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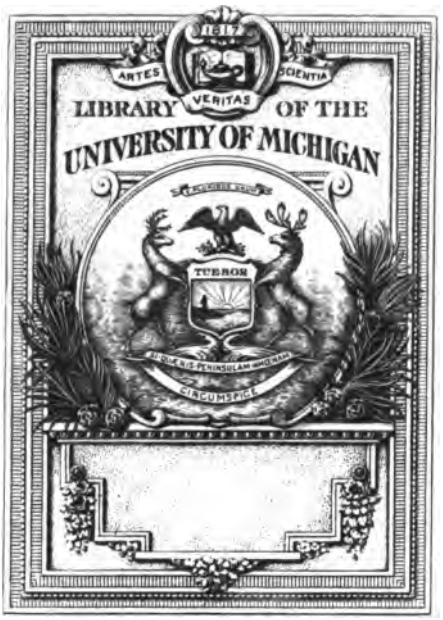

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PROCEEDINGS OF THE EIGHTH ANNUAL MEETING

OF THE

KANSAS ACADEMY OF SCIENCE

The eighth annual meeting of the Kansas Academy of Science was held in the Senate Chamber, at Topeka, beginning at 3 p. m. October 12th, and closing at 10 p. m. October 13th.

Among the proceedings of the Academy, the following will be of public interest:

A resolution was presented and passed as follows:

"Resolved, That the increasing popular demand for scientific information makes it a duty of members of this Association to embrace every appropriate occasion to aid the efforts of those seeking the introduction of the natural sciences into the common schools."

A committee, consisting of Profs. W. K. Kedzie, M. V. B. Knox and B. F. Mudge, was appointed to draft resolutions in regard to the necessity for a geological survey of the State, for presentation to the Legislature. The following report was unanimously adopted as an expression of the opinions of the Academy:

"It is now notoriously the fact that tons of choice minerals and fossils of Kansas are being shipped by collectors to the cabinets of eastern universities.

"It is exceedingly important for the educational and scientific interests of the State that these valuable specimens should be detained in the cabinets of the State.

"There is also a constantly increasing demand for more accurate and intelligent information as to the coal, gypsum, salt and other resources of the State.

"It is also well known that much money has been wasted in this State, in useless mining enterprises, which might have been saved by proper geological knowledge. Therefore,

"Resolved, 1st, That in the opinion of this Academy, a thorough geological survey of the State is imperatively needed.

"2d. This survey is necessary to develop fully the coal, salt, gypsum, lead, zinc, building stone, ochre and other resources of the State.

"3d. That such a survey should also include a thorough investigation of the rain-fall, spring and river system and general water supply of the State.

"4th. That the material already accumulated by this Academy, including lists of plants, birds, minerals and insects of the State, will be gladly contributed to this work.

"5th. That not only would such a survey place us on an equality with the more advanced States of the Union, but must prove for the State a most profitable monetary investment."

The resolutions were given to the Executive Committee of the Academy, who were directed to act thereon in conjunction with the State Board of Agriculture.

The following papers were read:

Additions to the Catalogue of the Lepidoptera of Kansas, by Prof. F. H. Snow.

Observations of the Botany of Kansas, with list of Plants observed since last year, by Prof. J. H. Carruth.

Descriptions of the several stages of Plagiodera scripta Fabr.—by William Osburn.

Remarks on some Characteristic Fossils of Western Kansas, by Prof. B. F. Mudge.

On the Hot Bluffs of the Missouri River in Nebraska, by Prof. W. K. Kedzie.

On the San Juan Mining Region, by Dr. W. H. Saunders.

On the Habits of certain Larvae, by Geo. F. Gaumer.

Catalogue of the Mammals of Kansas, with notes, by Prof. M. V. B. Knox.

On the Ozone in the Atmosphere of Kansas, by Prof. W. K. Kedzie.

Additions to the Catalogue of Kansas Birds, by Prof. F. H. Snow.

On the Chalk of Kansas, by Prof. G. E. Patrick.

On the Larva and Chrysalis of the Sage sphinx (Sphinx lugens Walker), by Prof. F. H. Snow.

The following officers were elected for the ensuing term of one year:

President—Frank H. Snow.

Vice Presidents—B. F. Mudge, J. H. Carruth.

Secretary—Joseph Savage.

Treasurer—R. J. Brown.

Curators—F. H. Snow, W. K. Kedzie, E. A. Popenoe.

The following commissions were also appointed:

Geology—B. F. Mudge, M. V. B. Knox.

Chemistry and Mineralogy—W. K. Kedzie, G. E. Patrick.

Mammalogy—M. V. B. Knox.

Ornithology—F. H. Snow.

Entomology: Lepidoptera—F. H. Snow; Coleoptera—E. A. Popenoe; Hymenoptera—William Osburn; Diptera—George F. Gaumer.

Botany—J. H. Carruth, John Wherrell.

Engineering—F. W. Bardwell, William Tweeddale.

Meteorology—J. D. Parker.

Philology—D. H. Robinson.

Committee on Publication—B. F. Mudge, Chairman; A. Gray, F. H. Snow.

Committee on Local Arrangements—P. McVicar, Chairman; A. H. Thompson, E. A. Popenoe.

The Society adjourned to meet in 1876, in Topeka—the date to be announced by the Executive Committee.

E. A. POPENOE, Secretary pro tem.

OZONE IN KANSAS ATMOSPHERE

By Prof. Wm. K. Kedzie, of the State Agricultural College.

We hear much from every quarter of the healthfulness so generally characteristic of the climate of Kansas; and no person long resident within the State can have failed to be strongly impressed by the unmistakable health producing and health-sustaining features of Kansas atmosphere.

None of us need to be reminded of the general immunity which we enjoy from the inroads of bronchial and lung difficulties; nor to recall the startling recoveries which we have all witnessed when invalids are brought into our midst completely prostrated by these maladies as they prevail in more eastern localities. I doubt not every thoughtful student has carefully sought for the adequate causes which have brought about so admirable a sanitary result. Our altitude above the sea is considerable, and yet is manifestly insufficient to account for so well marked a condition. Our atmosphere is proverbially a dry one; but an arid climate is not necessarily a healthful one. Now it is far from being the object of this paper to attempt any solution of this interesting problem, in which so many elements must obviously enter, and in the discussion of which any unanimity of opinion is well-nigh impossible. It is simply my desire to call your attention as a possible explanation of our climatic superiority, to the existence of an element which has thus far received little attention among us: the Ozone, everywhere prevalent in Kansas atmosphere. Nor is it any part of my intention to present here any elaborate discussion of the nature of this element nor of its supposed relations to the conditions of health and disease. This element has now been known to chemists barely thirty-five years, and yet ever since its discovery in 1840, by Schonbein, of Basle, it has probably received from chemists more universal attention with less satisfactory results than any other one body. It is only recently that a prominent member of the British Association pronounced any attempt to investigate the nature or relations of Ozone, "a delusion and a snare," and the great majority of English and American chemists have seemed disposed to "take him at his word," as its investigation has been by them almost wholly neglected. The whole matter seems to have been left to the researches of a few German and French chemists whose half contradictory results have appeared only in disjointed articles in the foreign periodicals. Indeed but one volume of English authorship, making any pretentions to thoroughness in the matter, has appeared; and even in this the subject is treated in a most fragmental and unsatisfactory manner.

But notwithstanding this disheartening meagerness of knowledge of the nature of Ozone and of the conditions in which it appears, there can be no shadow of a doubt that the relations which it sustains to organic life in every form are of most vital importance, and that we today are more generally indebted for our sanitary well-being to its indirect influence than we have as yet any conception. Now we know this Ozone to be an allotropic form of oxygen. We know it to be commonly produced by the action of electricity on the oxygen of our common air. Its peculiar odor as thus produced has been known from the most remote antiquity. Homer, in his Odyssey, speaks of the atmosphere, after the passage of the thunderbolt, as being "quite full of sulphurous odor," and it is a common experience of those who have happened near a lightning stroke that it is instantly followed by this strong characteristic odor. A positive proof of this fact, however, was furnished by a Swiss scientist, Buchwalder, who, while traveling in the Alps, was overtaken by a violent thunder storm in which his guide was instantly killed by a lightning stroke, and the powerful odor was at once apparent. Shortly afterward he visited the laboratory at Basle, in which Schonbein was manufacturing a large quantity of Ozone for experiment, when he at once expressed his astonishment at the strong "smell of lightning" which he had just observed a few days before in the thunder storm on the Alps. Thus the identity of the phenomena was plainly established. The same odor may be observed around an electrical machine during its op-

eration in a close dry room. The allotropic condition of Ozone, however, is best illustrated by a single experiment. We know that the metal silver remains bright and unaltered in dry oxygen gas. But let a strip of silver be enclosed in a tube of oxygen, and let a succession of electric sparks be passed through, Ozone will be produced and the silver will almost immediately become covered with a black deposit which is nothing else than silver oxide. On heating this black deposit pure oxygen gas will again be given off. The views of Schonbein as to the nature of Ozone are not at the present day generally accepted. He looked upon oxygen as an electrically neutral body made up of an electro-positive and an electro-negative atom. Its condition then pictured itself to his mind as O+O—, standing side by side. By the action of the electric current he considered its particles to become so altered in their mutual positions as to produce two distinct bodies: First, Ozone, represented O—O+O—; second, Antozone, represented O+O—O+.

This view is now, however, wholly abandoned. As to the existence of Antozone it is here entirely unnecessary to speak. It is now looked upon by the generality of chemists as probably nothing else than the per-oxide of hydrogen. Ozone itself is now regarded by leading authorities as merely condensed oxygen, with a density of one and a half times that of oxygen. Hence if we represent a working particle of oxygen by O_2, that of Ozone would be O_3. We would thus give it the equivalent 48. For the purposes of experiment we can produce Ozone by a great variety of methods: By a slow oxidation of phosphorus in a moist and confined atmosphere; by the decomposition of the vapor of sulphuric ether by the agency of a glass rod heated to temperature of 250° F.; or in large quantities by the decomposition of the permanganate of potassium by sulphuric acid. As evolved by all these methods it exhibits its remarkable properties: A colorless gas of a powerful, pungent odor (whence its name, which signifies "odor producer;") exerting a peculiar irritating effect upon the mucous membrane of the throat and lungs; and with the oxidizing characteristics of ordinary oxygen much intensified. It will attack metals and decompose binary salts which it is entirely beyond the power of ordinary oxygen to touch.

Thus much and briefly as to the nature of this remarkable body. Next as to its existence in our atmosphere. This is found by careful experiment to be all but universal, but varying immensely in degree and intensity as determined by surrounding circumstances, particularly the presence or absence of decomposing organic matter. The natural processes which produce Ozone in our atmosphere are most numerous and varied. Its production by atmospheric electricity has already been mentioned, and although the results from this cause are most startling it is not probable that its effects are at all proportionate to that of the numberless silent producers of atmospheric Ozone. Indeed it seems very probable that there is no process in nature in which oxygen is either absorbed or liberated in which there is not a proportionate quantity of Ozone evolved. Meissner has plainly proved that not only in rapid process of combustion, but in the slow process of decay, a certain quantity of Ozone is produced, the greater portion, of course, instantly disappearing when brought in contact with the decomposing matter, but still a recognizable portion escaping undestroyed into the general atmosphere. The mere process of evaporation from large bodies of water is also a most powerful contributor of Ozone to the atmosphere. But above all these, the latest researches in this fascinating field have indicated a third possible and more powerful source still: the process of vegetable growth. We know that the processes of vegetable nutrition depends primarily upon the fixation of carbon, that is, the absorption of carbonic acid from,

and the return of oxygen to, the atmosphere. Now Daubney has proved by careful experiment upon a slow current of air passing over a living plant that the liberated oxygen thus produced was accompanied by indications of Ozone. No matter how minute the amount thus produced, when we consider the enormous extent to which this operation is everywhere in progress, we must look upon it as a most probable and abundant source of Ozone to our atmosphere. This hypothesis, too, enables us to explain certain well known facts in vegetable nutrition otherwise inexplicable. Thus we know that many plants which contain the greatest amount of nitrogen in their composition are not always those which are most benefited by the use of nitrogenous fertilizers. Such plants are almost invariably large-leaved, exposing an immense foliage surface. Hence the query naturally arises whether these plants may not have the power of supplying themselves with nitrogen compounds through the indirect action of the Ozone exhaled from their foliage. We know that this element has the power of oxidizing the nitrogen of the atmosphere first into nitrous and then into nitric acids, which in combination with the atmospheric ammonia might thus be furnished the plant in no insignificant quantity.

But from whatever source produced, it is obvious that by far the larger portion of our atmospheric Ozone must, on account of its intense oxidizing powers, be almost instantly consumed by decomposing organic matter wherever present. Hence is explained the circumstances in which we find the most abundant evidence of its existence. The atmosphere immediately surrounding stables or outhouses, or over decaying refuse heaps will afford not the slightest trace of Ozone; not, we are to understand, that it may not be there produced, but, when formed, it is at once consumed by the oxidizing processes in progress in such localities. Hence we are not surprised to learn that in cities the indications of its presence are much more feeble than in the pure air of the country uncorrupted by organic effluvia. Even in so moderately a populated city as Manhattan, I have found the result of my Ozone observations much less striking than in the fresher atmosphere of College Hill, two miles away. In the atmosphere of Topeka I have found its amount still less. In densely populated, and especially in manufacturing cities, we of course find the diminution more startling still. The city of Lyons, France, has positively afforded not a single indication of the presence of Ozone, and so proverbially is this the fact that it has been dubbed among French chemists, "the town without Ozone."

In comparing the results of diverse seasons also we very naturally find its quantity in winter fully twice that in summer. This is accounted for not only by the fact that in the winter season our electrical conditions are much more energetic and intense, but more especially by the circumstances that the greater portion of the Ozone then produced in the atmosphere remains there undestroyed, the process of oxidation being then nearly at a stand-still and the organic matter of the earth frequently protected by a deposit of snow. For precisely similar reasons we find the reaction for Ozone much stronger at night than during the day. The maximum amount for the entire twenty-four hours is almost invariably just before sunrise; as by the condensation of watery vapor always taking place at that time, the air is freed from its organic impurities. But it is obvious that the amount of Ozone which we can measure in our atmosphere affords not the least indication of the amount which may have been produced there, for it is only possible for us to measure the residuum, that which remains undestroyed by oxidizable matter.

It is to be seriously regretted that the methods for quantitative estima-

tion of Ozone should be so imperfect and so liable to grave error. Numerous methods for such estimations have been devised, the greater proportion of them dependent upon its well-known oxidizing power. It is well known that Iodide of Potassium is perfectly unalterable in oxygen gas. Under the action of Ozone, however, it is instantly decomposed, caustic potassa formed and free Iodine liberated. A test paper has hence been constructed in which wine-red litmus paper is impregnated with a solution of Potassium Iodide and exposed to the action of the Ozone of the atmosphere. The extent to which this paper is blued by the action of the caustic potassa produced affords a basis for determining the amount of atmospheric Ozone present.

For my own use, however, I have preferred a test of Schonbein's own devising. It is dependent on the well-known property which free Iodine possesses of turning starch an intense blue color; a reaction so delicate that it will detect one part in a million. In the manufacture of the test paper I use the proportion, 1 part of Potassium Iodide to 10 of starch; first, boiling the starch in an excess of 200 parts of distilled water, and, when the mixture is cold, adding the Potassium Iodide. In this, strips of unsized paper are soaked and afterward dried carefully in the dark and in air as absolutely free from impurities as possible. As a basis of comparison I employ a color scale, by which the proportion of Ozone, varying from the merest trace to an abundant presence, is indicated by a series of ten corresponding blue colors, gradually deepening from the first to the tenth. Now, on exposing a slip of this prepared paper to the action of the atmospheric Ozone for a period of twelve hours, free Iodine will become liberated in it to an extent proportionate to the quantity of Ozone in that atmosphere. If the exposed slip be then dipped in water, a blue color from the resulting action of the Iodine upon the starch will then be produced, and by comparing this with our color scale the number of the corresponding color may then be recorded as the result of the observation. Thus a basis is formed by which observers in different countries are enabled by the use of these numbers to compare the results of their investigations. As a necessary precaution the test paper must be preserved in the dark, as the action of intense light itself will in time decompose the Potassium Iodide. When exposed also it must be carefully protected from violent wind, from direct sun-light or even from directly reflected sun-light. This I find is easiest to accomplish by suspending the slip in a plain wooden box without bottom and drilled abundantly with holes to allow a free access of air.

Employing this test of Schonbein's as a basis, the observations upon the quantity of Ozone, which for the year past have been in progress at the Agricultural College, have been most interesting and gratifying. They have established beyond a doubt the existence of an abundance of Ozone in the atmosphere of Kansas. While such observations can of course prove of value only when extended through a long period of years, results of great interest have already been obtained. Two series of daily observations have been made. First, a day observation, the result obtained by exposing the paper from 7 a. m. to 2 p. m. Second, a night observation, the result of which is best obtained by an exposure from 9 p. m. to 7 a. m. The relations of the two are well shown in the means of the obesrvations for the month of January. The average of the day records for this month was 6.03; that of the night 7.50. In four observations for the night records of January, the scale gave the maximum number 10. During the succeeding months these numbers slowly decrease. For the month of May, for instance, the daily average has become 5; for that of July it has fallen to 3.53; in August, to 3.77; while in September it has again risen to 4.75; and thus it will go on increas-

ing until the succeeding January. Moreover, during the summer months the difference between the day and night observations becomes less and less, those of the day sometimes even exceeding those of the night.

Probably one of the most extensive series of observations of this character in the United States has been that conducted by the Chemical Department of the State Agricultural College of Michigan, and I have been much interested in noticing by comparison how uniformly the results obtained in Kansas exceed those of Michigan. I here append a table giving the means of the day and night observations in the two States for the first eight months, from January to August inclusive, of the year 1875:

MONTHS	Kansas		Michigan	
	Day.	Night	Day.	Night.
January	6.03	7.50	5.52	5.93
February	5.66	7.82	5.78	6.57
March	5.36	5.88	5.70	6.19
April	5.26	6 25	3.73	8.96
May	5.00	5.00	3.19	4.03
June	6.00	6.00	3.96	3 66
July	3.53	3.28	3.52	3.22
August	3.99	4.00	3.68	3.68

Moreover, this element of Ozone in our atmosphere, while of itself most vitally important, is above all valuable as establishing a pure atmosphere, one practically free from organic effluvia, the acknowledged source of malarial disorders.

But it is obviously entirely beyond either the limits or province of this paper to attempt any consideration of the complex relations of Ozone to health and disease. At some future meeting of this Academy it may perhaps be my privilege to attempt some such discussion. Probably no problem could be mentioned in which the opinions maintained by prominent scientists have been so discordant and so chaotically diverse. By one class of disputants the very possibility is denied of any connection between the presence of Ozone and the prevalence or absence of certain types of disease. On the other hand, by another party equally eminent it is maintained that the relations of this element to sanitary conditions are of most vital and paramount importance; and that it only remains for us to reveal them by careful research. Leading spirits of this latter party have expressed a firm belief in the near proximity of a period of enlightenment, when in addition to piping our dwelling-houses for water and gas, we shall not only add an additional pipe for carbonic acid under pressure to shield us from the dangers of conflagration, but above all a fourth tube for regulating our domestic atmosphere by a well directed stream of Ozone. Indeed it is only recently that a stock company was organized to this end in the city of Chicago, having as its consulting oracle a well-known western chemist, and for its avowed object the manufacture, upon an extended scale, of Ozone for the purification of the private residences, public buildings and sluice-ways and sewers of the most odorous city. Unfortunately, however, the efforts of this company prematurely terminated in a prospectus soliciting purchasers of stock! Enthusiasts in this matter must bear in mind that the presence of an excess of this Ozone is scarcely to be less deplored than its utter absence. It is well known that when existing in the atmosphere in too great an abundance, it occasions attacks of bronchitis and other bronchial disorders. An explanation has been thus suggested by medical authorities of the prevalence of these diseases, in certain seasons, in northern Minnesota.

What is above all now needed is a general series of careful, patient and conscientious observations extending through long periods of years. It

is only from such a foundation of well authenticated facts, that we can hope to deduce results of any importance. The investigators of America are now rapidly awakening to the importance of this work. Earnest observers are beginning thorough records in various portions of the United States. It has been my object to call the attention of the gentlemen of this Academy to the importance of organizing a series of careful records of the Ozonic phenomena of Kansas. To any one disposed to assist in this work I shall take pleasure in furnishing color scales, Iodized paper and record blanks, simply requesting that a copy of these be returned to me at the close of each month for tabulation.

The solution of this question is destined to become, from a chemical standpoint, one of the most important problems of the century before us; but a problem whose solution can only be purchased by long years of untiring study.

Kansas State Agricultural College, October, 1875.

THE NEBRASKA HOT BLUFF.

By Prof. Wm. K. Kedzie, of the Kansas State Agricultural College.

The somewhat startling natural phenomenon to which it is the object of this paper to call attention, is a bluff of the Missouri river, on the northern boundary of Nebraska, and near the village of Ionia. It is also not very far distant from the opposite town of Yankton, Dakota, and has been principally visited and described by prospectors from our latter city.

It is in appearance a quite ordinary river bluff, about a thousand feet in length, one hundred and fifty feet high, and sloping from the river by which its base is washed at an angle of 70 or 75 degrees. By the undermining action of the river a large mass, some five hundred feet long, one hundred feet high, and twenty to thirty feet thick, was some months ago scaled from the face of the bluff and fell to its base, forming a large mass of debris rising at some points fully forty feet above the level of the river. It is this immense fragmental mass which has displayed the striking phenomena so terrifying to the ignorant and superstitious of the neighborhood, and which very beautifully illustrates the important chemical transformations constantly in progress within the earth's crust.

Attention was first called to the peculiarities of this locality by a party of miners who were prospecting for indications of coal veins. On passing over this mass of debris, they found steam escaping from the crevices at every point. The ground was also perceptibly heated, and by placing the ear to the earth a crackling sound was heard proceeding from below. An opening was made in the mass to the depth of two feet, when the heat became so intense as to be scarcely endurable. Upon perforating the heap still further with an ordinary augur, the temperature was found to be rapidly increasing with the descent. An ordinary thermometer with a range of one hundred and fifty degrees was thrust into the augur-hole thus made, when the mercury shot up so rapidly to the top of the tube that it had to be instantly withdrawn to prevent the bursting of the bulb. All these circumstances carefully considered seem to indicate that the temperature of the interior of the mass was fully 212° F. The exterior was, as a rule, coated with a hard incrustation of mineral salts brought up by capillary action from below; on breaking this the interior was found in a fine pulverulent

condition, closely resembling the slaking process of lime. The intense heat of the mass made itself felt for many square rods around, and the steam escaping from the crevices was of a peculiarly sour, pungent odor. The mass is completely impenetrated by an abundance of beautiful crystals of Selenite (Gypsum); many of the crystals microscopic, others aggregated into masses of considerable size, and others still most perfectly rhombodial crystals upwards of a pound in weight. Peculiar incrustations are also noticed on the face of the partially decomposed rock, in some cases in the form of a white flaky powder, having the taste of common alum; in others in the form of efflorescent crystals giving the marked flavor of Epsom salts. As already intimated the superstitious denizens of this region at once leaped to the conclusion that a young volcano had burst upon them in all its fury, and fortified themselves with due courage to meet the emergency. Attracted by their somewhat exaggerated accounts, Mr. A. W. Barber, the editor of the Yankton Press, visited the locality and made a careful and intelligent examination. It is to his courtesy that I am indebted for an interesting box of specimens of the minerals here undergoing such vigorous transformations, and for a full account of the nature of the bluff. A chemical examination of these specimens reveals at once the nature of the interesting transformations here in progress, which, while known to be actively in operation in many localities in Europe, have as yet been observed at comparatively few points within the limits of the United States.

This so called "hot bluff," then, consists of two separate and mineralogically distinct ingredients. The main portion of the bluff from the base up to the height of a hundred feet consists of a bluish gray rock of uniform texture, somewhat schistose, soft and easily yielding to the knife, and to the eroding action of the river. So evenly balanced are its constituents that it seems a matter of question whether it should be properly called an argillaceous limestone, or a calcareous slate or argillite. For while upon analysis it is found to contain but about twenty per cent. of the earthy carbonates of calcium and magnesium, it yet offers all the characters of a magnesio argillaceous limestone, effervescing but slowly in cold acids, but with quite violent action upon elevation of the temperature.

Next above this the upper and remaining fifty feet of the bluff is completely interwoven with seams of varying thickness of a soft, friable, blue-black shale, in which exist in great quantity microscopic crystals of the bisulphide of iron ($Fe\ S_2$), commonly known as iron pyrites. Nuggets of the same mineral are also found abundantly distributed over the face of the bluff. Now it is the products of the decomposition of this iron pyrites which form the active agents of all the violent chemical reactions here observed. We know that when exposed to the influence of atmospheric oxygen and moisture this mineral is rapidly decomposed, absorbing oxygen and becoming converted into Ferrous Sulphate, ($Fe\ SO_4$), commonly known as green vitrol, and free sulphuric acid. Represented by formulae, this change would be: $Fe\ S_2+H_2O+70=Fe\ SO_4+H_2SO_4$. This Ferrous Sulphate again on more extended exposure is still further oxidized and becomes Ferric Sulphate or Sesqui-Sulphate of Iron ($Fe_2\ 3S\ O_4$). This in its turn is a very unstable compound, and when brought in contact with other bases readily yields up its sulphuric acid and becomes converted into the hydrated oxide of iron. When exposed in considerable mass, this decomposition of iron pyrites of course proceeds but slowly, and specimens are frequently found illustrating the change in all its gradations. But when, as in the soft shale of this Nebraska bluff, it is found in the form of fine crystals appearing as glistening specks to the naked eye, its decomposition is very rapid and an

abundance of free sulphuric acid is produced. Hence it will hardly be a matter of surprise when I state that the soft shale from the upper layers of this bluff has become so charged with free sulphuric acid as to be strongly sour to the taste and acid in reaction. In fact, on allowing a specimen of this shale to remain undisturbed in my laboratory for several months it was found to afford 5.35 per cent. of sulphuric acid in the form of the freely soluble sulphates of iron and aluminum.

Thus we have in the chemical constitution of this hot bluff a perfect explanation of the startling phenomena which are there occurring. Below, a rock largely consisting of earthy carbonates freely decomposable by the presence of free acids. Above, a series of layers completely charged with an abundance of this free acid. When, by the scaling off of the face of the bluff, these agents are intimately mixed in an immense mass of thousands of tons of debris the free acid immediately attacks the easily yielding carbonates with great violence, and a "hot bluff" very naturally springs at once into existence. The intense degree of heat produced, however, is from another and more complex cause than this. If the simple acid shale were by itself without the limestone, piled in a large heap, and water added, there would be a very rapid rise of temperature within from the greatly increased rapidity with which the process of the oxidation of the iron pyrites would go on under these circumstances. It is well known that in the shales of Whitby, England, when thus piled and moistened with water, the oxidation of the pyrites will develop so intense a degree of heat as to spontaneously set fire to the bituminous matter which the shale contains. But when, as in the case of this Nebraska bluff, to the heat generated by this rapid oxidation produced by increased exposure to air and the water of the river and rains, there is added the violent avidity with which the free sulphuric acid attacks the carbonates of lime and magnesium, the effect is naturally powerful and startling in the extreme.

Under these encouraging conditions many interesting chemical compounds are here in the process of formation. By the decomposition of the carbonate of calcium by the sulphuric acid, magnificent crystals of Selenite (Gypsum), are now forming in immense abundance. The crystals are exceedingly perfect and beautiful; many of them somewhat rare in form, long, slender, needle-shaped crystals, but still perfect rhomboidal prisms with bevelled edges. In some instances in the solid mass of the bluff itself, where the layers of the limestone and the acidified shale are conjoined, there are formed seams of a half inch or more in thickness completely filled with interradiating crystals of Selenite partially coated with the yellow hydrated oxide of iron. By the decomposition of the magnesium carbonate there is here formed magnesium sulphate or Epsom salts distributed over the rock in a very minute incrustation of efflorescent crystals.

Finally, by the slow decomposition of the argillaceous or clayey portions of the rock itself there is produced the Sulphate of Aluminum in minute crystalline tufts called on account of its form "Feather Alum." These last two compounds suggest an economical phase of what has thus far been simply an exceedingly interesting chemical phenomenon. It is well known that the great proportion of the common alums are manufactured from shales almost identical in nature with those which form the black seams of this Nebraska bluff. In the great English alum fields, for example, the shale, full of partially decomposed pyrites, is collected, piled in oblong heaps, and slowly fired to completely carry out the oxidation which has been begun. A large quantity of free sulphuric acid is thus produced which attacks the shale forming Aluminum Sulphate. This is removed by leaching

with water and the addition of some available form of potash or ammonia is all that is needed to crystallize out the common potash or ammonia alums of commerce. Now, in the case of this Nebraska bluff, this oblong mass of heated debris bears no very distant resemblance to a "curing heap" of an alum manufacturer. The presence of the limestone is, to be sure, most unfortunate, and would necessarily be avoided if the acidified shale was to be handled with a view to profit. The small quantity of the magnesium carbonate present would be by no means unpropitious, as the manufacture of Epsom salts and the alums is frequently carried on together at a handsome profit. If the accounts of intelligent observers are to be accepted, there would seem to be little doubt that this region may prove available in these branches of manufacture. But whether thus utilized or not, this display is surely a most fascinating one to the chemist and mineralogist—nature seeming, in some degree, to have pulled aside the curtain and given us a peep behind the scenes, where we are permitted to see her in the very act of forging these marvels of crystalline creation.

KANSAS CHALK.

By G. E. Patrick, Professor of Chemistry and Physics, Kansas University.

The existence of chalk in North America is a comparatively new fact in science. Prof. Dana, in his Manual of Geology, (editions previous to the last, 1874,) says, in speaking of the Cretaceous beds of this country, "they include in North America no chalk." Within the last few years, however, it has become generally known to the scientific men of Kansas, that there occur, in the Cretaceous formation of this State, vast beds of what must be considered a true chalk. Specimens of this have been sent to Prof. Dana for examination, with the result that in the last edition of his Manual, (1874,) he corrects the statement above quoted, and acknowledges the existence of chalk in the Cretaceous of Kansas.

The beds are of great extent, so great that in case a demand for it should ever arise, the supply would be practically limitless. They are in the western part of the State, from three hundred to three hundred and twenty miles west of Kansas City, and within three miles of the Kansas Pacific Railroad.

The chalk is, as a rule, very soft and fine grained, though in this respect it varies with the amount of impurities. The color of many specimens I have seen, is a snowy white; but a large portion of it is slightly tinged with yellow, by oxide of iron.

Examined under the microscope, it appears perfectly amorphous—a simple aggregation of shapeless particles. The Rhizopod shells, which almost universally occur in the chalk of the Old World, sometimes comprising nearly its entire substance, seem to be quite wanting in our Kansas chalk. With a good microscope, and a high power, I have been unable to detect any trace of them.

To believe that these shells were originally in the chalk, during its formation and subsidence, and that by water action they have become so completely disintegrated as not to leave a trace, involves too great an assumption; hence it is my opinion that our chalk was not formed, like that of England and France, by the aggregation of myriads of Rhizopod skeletons—

that it is not in any way the product of animal life—but that its origin was purely chemical. The absence of flint, as far as observed, seems also to add weight to this view.

The amount of impurity varies of course, in different samples of the chalk, but in no specimens that I have seen does this amount exceed fifteen to sixteen per cent.

Two samples yielded, upon analysis, the figures given below. No. 1 was a fine specimen of snowy whiteness; No. 2 had a light yellowish tinge, and was as poor a sample as I could select.

	No. 1.	No. 2.
Moisture	.34	.58
Insoluble in acids, (silicia, lime and alumina.)	.69	11.40
Alumina, (little oxide of iron)	.43	.97
Ferrous carbonate	.14	2.83
Calcium carbonate	98.47	84.19
	100.07	99.97

The value of these deposits, from a practical point of view, I believe to be considerable; and that this value may be realized, capital and enterprise only are needed.

Among the possible uses to which this material may be applied, I would mention, as giving the greatest promise of profit, the manufacture of whiting of the various grades, for putty, for calcimining et cetera; and the manufacture of Portland cement. The latter is a branch of industry not yet established in the United States; and this simply for the reason that in the older States where such a manufacture would otherwise have arisen, chalk, an essential in the economical manufacture of this cement, was not to be found.

One other essential, (and the only other), is clay. Only where these two materials are found in quantity, can the manufacture be most profitably carried on; and these conditions are fulfilled in this country, as far as our present knowledge extends, only in this State.

Portland, on account of its vast superiority over our American cements, has, in our growing cities, a large sale—which, however, is checked by its high price consequent upon importation. Its price is from two to five times that of the various American cements.

Common hard limestone can be used instead of chalk, in the manufacture of Portland, by previously grinding it to a fine powder in a mill; or by burning it to lime in a kiln, and then slaking. But consumption of power required to reduce it to powder, or of fuel used in the extra kilning, places it under great disadvantage when compared with chalk.

With this disadvantage in view, however, General Gilmore, Major Corps of Engineers U. S. A., has estimated accurately the cost per ton of making Portland cement in this country, using hard limestone instead of chalk.* After computing the exact cost at current prices, and adding a margin of twenty per cent. for contingencies, he sums up as follows: "In the United States the cost would not vary greatly from $10.00 per gross ton. * * * * * This estimate is believed to be a liberal one. It shows that Portland cement can be manufactured in this country at a cost less by from twelve to fourteen per cent. than the wholesale market price of Rosendale, omitting the cost of barrels in both cases."

*Professional Papers of Corps of Engineers of U. S. A., Number 19.

Making use of chalk, instead of hard limestone, this cost would be greatly reduced.

A large number of manufacturing experiments, which I have conducted upon a small scale in the laboratory, have proved by practical demonstration that there can be made from materials at hand in this State, a Portland cement quite as good in quality as the imported article; and that this can be done in Kansas at an expense much less than in any other State in the Union, is equally well established.

ANALYSIS OF KANSAS SOILS.

By G. E. Patrick, Professor of Chemistry and Physics, in University of Kansas.

I have recently submitted to analysis samples of two soils from Wallace county, Kansas. As the results show them to be quite rich in certain elements of plant-food, and as no soils from that part of the state have heretofore been analyzed, it may not be out of place to submit a report of my analyses to the Academy.

Both samples were collected in September, 1875, by Mr. S. W. Williston, member of Professor Mudge's geological party. Neither of the plats from which they were taken has ever been cultivated.

Both samples were thoroughly air-dried, at ordinary temperature of the laboratory, before analysis.

SAMPLE NO. 1.

This was an upland soil, taken from the high prairie of Smoky Hill Valley, near Monument Rocks, Wallace county.

It yielded upon analysis:

Water		3.449
Organic matter		5.224
Soluble in cold hydrochloric acid	Oxide of Iron	1.778
	Alumina	.721
	Lime	1.618
	Magnesia	2.084
	Potassa	.202
	Soda	.002
	Silicic acid	.023
	Sulphuric acid	.078
	Carbonic acid	2.567
	Phosphoric acid	.118
	Sodium chloride	.009
Insoluble in cold hydrochloric acid		82.127
		100.000

SAMPLE NO. 2.

This sample was taken from the upper loam of the Smoky Hill Valley bottom lands, thirty miles east of Fort Wallace, Wallace county.

It yielded upon analysis:

Water		1.895
Organic matter		3.039
Soluble in cold hydrochloric acid	Oxide of Iron	1.503
	Alumina	.557
	Lime	4.268
	Magnesia	.422
	Potassa	.214
	Soda	.038
	Silicic acid	.050
	Sulphuric acid	.041
	Carbonic acid	3.510
	Phosphoric acid	.173
	Sodium chloride	.003
Insoluble in cold hydrochloric acid		84.287
		100.000

One fact indicated by the above figures deserves special notice, namely, that of the alkaline bases present in the soluble portion of both these soils, potassa constitutes nearly the entire amount, while soda is found in but small quantity, especially in No. 1, where it is well nigh absent.

Considering that these soils have never been treated with fertilizers, the amount of phosphoric acid is almost exceptionally large.

The better to illustrate these points, and to facilitate general comparison, I have arranged these analyses, together with those of four other soils, in the following table. Nos. 1 and 2 are the Wallace county soils; No. 3 is from a plat in Wyandotte county, Kansas, that had been for eighteen years in blue-grass; No. 4 is an English clover soil, considered good; Nos. 5 and 6 are from Belmont county, Ohio, both upland; No. 5 a surface soil; No. 6 a subsoil.*

		Wallace county upland,	Wallace county bottom.	Wyandotte Co.	England	Belmont Co. Ohio, upland surface soil.	Belmont Co., Ohio, upland subsoil.
		No. 1.	No. 2.	No. 3.	No. 4,	No. 5.	No. 6.
Water		3.449	1.895	3.800	.....	2.260	2.220
Organic Matter		5.224	3.039	5.440	5.340	7.740	4.400
Soluble in hydrochloric acid	Oxide of Iron	1.778	1.503	2.575	6.070	8.327	6.810
	Alumina	.721	.557	4.325	4.510		
	Lime	1.618	4.268	.675	4.205	1.550	2.830
	Magnesia	2.084	.422	.063	1.270	2.333	3.343
	Potassa	.202	.214	.048	.520	.920	.027
	Soda	.002	.038	.125	.160		
	Silicic acid	.023	.050	.....	.....	.....	.....
	Sulphuric acid	.078	.041	.386	.196	2.340	2.820
	Carbonic acid	2.567	3.510	.....	3.305	.....	.....
	Phosphoric acid	.118	.178	.080	.150	.032	.087
	Sodium Chloride	.009	.003	.045	.030	.....	.....
Insoluble in hydrocloric acid		82.127	84.287	82.157	73.840	74.498	77.463
		100.000	100.000	99.719	99.590	100.000	106.000

* Nos. 3 and 4 are taken from the Report for 1874, of the Kansas State Board of Agriculture. Nos. 5 and 6 are from the Report of the U. S. Commissioner of Agriculture, for 1869.

ANALYSIS OF SALT.

By G. E. Patrick, Prof. of Chemistry and Physics, in University of Kansas.

The purity of Kansas Salt, although its manufacture is a new industry in the State, has already been the subject of considerable remark. While it is very improbable that all the brines of the State will furnish salt of remarkable purity, yet it is worthy of notice, as a promising fact, that of those thus far examined, nearly every one has yielded a salt of most excellent quality.

To the number of such brines already known, I have one to add. The sample was from Great Bend, Barton county, and was taken from a well, at a depth of about four feet below the surface of the ground. Collected by Prof. B. F. Mudge. It was clear and sparkling, and very nearly free from calcium and magnesium carbonates, which when present in quantity are troublesome, from the fact of their deposition upon boiling, in the form of "scale."

It showed a specific gravity of 1.062 or 8.8 Baume—a great density considering that it was almost a surface water. Its contents of pure salt was one bushel, to about 95 gallons of the brine.

I have analyzed two samples of salt made from this brine, the samples being taken from salt made at different times, as a check against untrustworthy results, from accidental impurity or excessive purity.

Both salts were made with no extra precautions to insure purity, and fairly represent the quality of the marketable article for table use.

They gave upon analysis:

	No. 1	No. 2.
Sodium Chloride	96.24	96.06
Magnesium Chloride	1.22	1.56
Sodium Sulphate	1.65	1.87
Calcium Sulphate	.89	.51
	100.00	100.00

The entire absence of calcium chloride is a merit of this salt not to be overlooked.

CALAMITES.

By M. V. B. Knox, Professor of Natural Science, Baker University.

In the soft sandstone on the banks of a creek about two and one-half miles southwest of Baldwin, are found Calamites in great numbers. The quarry is west of the Dr. Cowgill farm, at the crossing of the main road from Prairie City, over a small branch of Tahwo Creek. The Calamites are found in greatest abundance and of best quality a little north of the bridge, on the west bank.

During the winter of 1873-4, while passing down this creek in search of specimens, I noticed some Calamites cropping out of the rock, and afterwards succeeded in securing a few fine ones, but did not work the quarry

to any extent, as there was in our cabinet a fine lot of Calamites gathered from various other points about Baldwin. Some time last winter Prof. Mudge, accompanied by Mr. Joseph Savage of Lawrence, came to Baldwin, having heard of this quarry. Armed with a strong, sharp iron bar for splitting up the rock, we went there with some students to assist us, and in the course of three hours secured as many as fifty good specimens, some fifteen of them being "tips," of great beauty and perfection. Since then we have taken out and put in our cabinet about two hundred good specimens for preservation and exchange, while a great many more have been taken out for the State University and for different individuals. There are several other places about town at which Calamites are found, probably in the same layer of sandstone, but none yields specimens like this. Prof. Mudge thinks there is no other quarry equal to this one, in the west.

These Calamites represent the species cannaeformis, and transitionis, and others which I have been unable to identify with my limited literature on this group of fossils. They vary greatly in size, some being less than half an inch in diameter, while others are four or five inches. The longest continuous specimen is about twenty-eight inches. They exist in vast numbers in small areas, some small slabs of rock revealing them by the dozen. Of so-called "tips," the most valuable specimens, we have found three kinds. The most common is pyramidal in shape, three or four inches in diameter at the base, and six or eight inches in length, the apex or point being deflected. Another kind is small, less than an inch in diameter, with the point rounded, while the preceding one is sharp. The third, of which I have found but one specimen, is slender, sharp, wedge shaped, and with very fine striae. Lyell figures some of these tips, and comes to the conclusion that they are the roots of the Calamite instead of the top of the stalk. He and Dr. Dawson found, in Nova Scotia coalfields, these tips projecting downwards in position, thus showing their nature beyond question. He thinks too, that they are the striated piths, instead of being the outside of the stem. He is borne out in these views by several able European geologists. In one or two of these specimens in our cabinet, I have found a mark that is not mentioned either by Lyell or Dana. It is a deep scar close to the joints, as large as the end of one's finger. They occur in vertical series at alternate joints, and one-quarter around the stem. Are they the marks of branches? Are the very small fossils only the branches of the main trees? The rarity of these large scars suggest proof of Lyell's position, that the most of our Calamites are only casts of the piths.

In connection with this quarry and others about Baldwin, I have found a fossil as yet not identified, but which I surmise to be roots of Calamites, like underground stems or root-stalks. They are from half an inch in diameter to two inches, and I have secured some a foot long. They are not marked with striae lengthwise, but are decidedly rugose transversly, like roots of trees growing at present. There seem to be no marks of joints or branchings. In every instance of extensive Calamites, they are found, and only there.

Authors disagree in locating the place of Calamites in the vegetable kingdom. Most, however, among them Dana, place them in Lycopodiaceae, the Equisetum, or gigantic "horsetail," the only representative now living being the scouring rush. Still there are many marks of their belonging to Gymnosperms. In connection with these Calamites near Baldwin, are found various leaves, flags, and some well defined casts of Cordiates. Also well preserved Sigillaria.

KANSAS MAMMALIA.

By Professor M. V. B. Knox, of Baker University.

FELIDÆ.

1. Felis concolor Linn.—American Panther. A specimen taken about nine years ago at Valley Falls, by Mr. Whitman, and identified by him. Probably only a transient visitor. Now and then known as crossing different parts of the State.

2. Lynx rufus Raf.—Bay Lynx. Wild Cat.* Quite common in timber in all parts of the State.

CANIDÆ.

3. Canis lupus Aud. and Bach.—Gray or Timber Wolf.*—Not uncommon in all parts of the State. Many are taken on the plains every winter for their splendid fur that is used for muffling robes.

4. C. latrans Say.—Coyote. Prairie Wolf.* Very destructive to domestic fowls. This and C. lupus seem to be getting more common in older parts of the State.

5. Vulpes fulvus Desm.—Red Fox. Common in all parts of the State.

6. V. velox Say.—Kit Fox. Swift. Rare.

7. V. Virginianus Rich.—Gray Fox. Rarer than the Red Fox. One taken near Baldwin, November, 1874, by John Griffith.

BASSARIDÆ.

8. Bassaris astuta Licht.—Texas Civet Cat. Allen. Rare in western parts of the State.

MUSTELIDÆ.

9. Mephitis mephitica Shaw.—Common Skunk.* Frequent.

10. M. bicolor Gray.—Little Striped Skunk. Polecat.* More frequent than the common Skunk. A pest to farmers. Said, however, by Mr. Joseph Savage, of Lawrence, to enter the burrows of the Pouched Gopher, and to destroy them. Also, it is well established that they destroy rats about barns.

11. Putorius noveboracensis DeKay.—White Weasel.* Occasional. Winter coat does not always become white in this State.

12. P. vison Forster.—Common Mink. Frequent about the streams.

13. P. nigrescens Aud. and Bach.—Little Black Mink. Rare. Specimen reported in Baird, Report, p. 180, as taken by Lt. D. N. Couch, Fort Leavenworth.

14. Lutra Canadensis Sab.—Otter. Rare. Found in north parts of the State.

15. Taxidea Americana Schreb.—Badger.* Occasional.

URSIDÆ.

16. Ursus Americanus Pallas.—Black Bear. Occasional in timber in central parts of State.

PROCYONIDÆ.

17. Procyon lotor Linn.—Raccoon.* Common.

* Specimens marked * in Baker University Cabinet.

BOVIDÆ.

18. Bison Americanus Gm.—Buffalo. American Bison. Vast numbers roam over the western parts of the State, migrating northward in the spring and southward beyond the Arkansas river in the autumn. They are being slaughtered by the ten thousand annually, for their hides, meat, bones, and the sport of killing them. Should not legislation put a stop to this wholesale destruction?

EQUIDÆ.

19. Equus caballus Linn.—Wild Horse. Adventitious from Europe. Considerable herds are seen in the west part of the State, especially southward, along the Arkansas River region.

The manner in which these are captured by a man living near Osborn, is this: He goes to the region of the divide between the Platte and the Arkansas rivers, where the wild horses seem inclined to spend the summer. With a team and extra saddle horse, he starts a troop of wild horses, pursuing them, only walking his team, but never permitting the wild horses to stop for a moment. At night he does not camp till after dark, when he feeds his team well on substantial food brought with him, while the tired wild horses rest and wait till morning to feed. But by daylight he has his team well fed and rested, ready to start the hungry herd on its useless flight. By the fourth day the wild horses are worn, hungry and weak, when he takes his saddle horse, reserved for this time, and easily lassoes the wild ones, returning home with the rich results of his strange chase.

From reliable information gathered the past summer in the southwest, I find that the wild horse breeds in Kansas, thus entitling it to a place in our list of mammalia. Not unfrequently when crossing the plains in the early part of the season, the traveler's camp is approached by a troop of wild horses. In well established instances mares have been coaxed from the camp of the traveler, and taking to flight with their new wild lord, have joined his already considerable seraglio, and have been wholly lost, probably becoming veritable wild horses. Certain other domesticated animals at times show a decided inclination to take again to their wild habits.

CERVIDÆ.

20. Cervus Canadensis Erxl.—Elk. Quite common in the west parts of the State.

21. C. macrotis Say.—Mule Deer. Allen. "More or less common along the wooded portions of the streams, especially on the Smoky and the Paradise."

22. C. Virginianus Bodd.—Virginia Deer. Frequent in large bodies of timber in different parts of the State.

ANTILOCAPRIDÆ.

23. Antilocapra Americana Ord.—Pronghorn. Antelope. In great numbers on the western plains, in herds of ten or twenty. The young are easily tamed.

VESPERTILIONIDÆ.

24. Lasiurus noveboracensis Tomes.—Red Bat.* Occasional. Entering houses evenings for catching flies.

25. L. cinereus Allen.—Hoary Bat.* One taken in College building, Baldwin, 1874.

* Specimens marked * in Baker University Cabinet.

26. ——— ——— Bat.* Taken at Baldwin, 1874. Not yet determined.

SORICIDÆ.

27. Blarina Carolinesis Bach.—Shrew.* Rare.

MURIDÆ.

28. Jaculus Hudsonius Zimm.—Jumping Mouse. Baird. A specimen taken in the Baldwin City Nursery, of Mr. Plasket, and identified by Miss Amanda Plasket, of Cornell University, Iowa. Taken also at Lawrence, by Prof. Snow.

29. Mus musculus Linn. Common Mouse.* Everywhere. An albino specimen was placed in our cabinet, April, 1872, by Miss Ella Deane. White stripe on the back and sides.

30. M. decumanus Pallas.—Brown Rat.* Ever attending man in his "Westward Ho."

31. Hesperomys leucopus var. sonoriensis Exrl.—White Footed Mouse. Allen. Found by him at Fort Hays.

32. H. Michiganensis Aud. and Bach.—Prairie Mouse. Not plenty.

33. H. leucogaster Maxim.—Missouri Mouse. Coues.

34. H. palustris Harlan.—Rice Field Mouse. Coues. Specimen identified by B. F. Goss, Neosho Falls.

35. Arvicola riparia var. longipilis Ord.—Meadow Mouse.* Rare. One sent to us by Esquire Rice, Black Jack, 1875. Taken at Lawrence by Prof. Snow.

36. A. austerus L. C.—Prairie Meadow Mouse. Coues.

36a. A. austerus var. cutata Cope. Coues.

37. Ochetodon humilis Aud. and Bach.—Harvest Mouse. Coues.

38. Neotoma floridana Ord.—Wood Rat.* Common along the streams of the middle and western parts of the State. They build nests by piling up sticks and pieces of bark, to the height of two or three feet, often about the base of a tree or stump. In the middle of these piles they have a nest of dried grass and leaves.

39.——————— Mouse.* Taken at Coal creek, 1873, by C. K. Jones. Not yet identified.

40. Sunaptomys Cooperii—Cooper's Lemming. Coues. Taken at Neosho Falls by Col. Goss.

41. Fiber Zibethicus Cuv.—Muskrat. Now and then found along streams.

TALPIDÆ.

42. Scalops argentatus Aud. and Bach.—Prairie Mole. Silver Mole.* Frequenting gardens and yards, damaging bulbs, etc.

GEOMYIDÆ.

43. Geomys bursarius Shaw.—Pouched Gopher.* A well known pest, marking his course across fields by a line of small piles of dirt. Destruction to hedges. Said to find a deadly enemy in the Little Striped Skunk.

44. G. breviceps Baird.—Short Headed Gopher. Taken by Dr. A. W. Hammond, at Fort Riley. Specimen in Smithsonian Institute. (Baird's Report, p. 378.)

45. Dipodomys Ordii Woodh.—Kangaroo Rat. Common in southwest parts of the State. Found at Sargent.

* Specimens marked * in Baker University Cabinet.

46. D. Phillippi Gray.—Kangaroo Rat. Taken at Osborn by Richard Foster. Specimen in Washburn College, Topeka.

47. Perognathus fasciatus Maxim.—Kangaroo Rat. Taken at Topeka, Kansas, and identified by E. A. Popenoe.

48. Castor Canadensis Kuhl.—Beaver. Common along most of the large streams. Getting scarce in the eastern parts of the State. Does much damage to timber along the streams. Seldom builds dams or huts in Kansas, but lives under over-haging banks and roots.

SCIURIDÆ.

49. Sciurus ludovicianus Custis.—Western Fox Squirrel.* Frequent in all heavy bodies of timber.

Of this squirrel I have secured three well marked varieties. The first is that commonly found, the back grizzled black, gray and rusty, the under parts yellowish red. The second variety is dusky. The back is reddish brown and black, the black predominating. The belly is dark rusty. The face, nose, and cheeks, are almost pure black. A heavy line of glossy black runs down the front side of all the legs. The fur is short, thick and fine. The third variety is black. A slight annulating with lighter of some of its fur, tinges it a little with rusty, but the general color is glossy black. Brownish beneath, but there almost black.

50. S. Carolinensis Gm.—Gray and Black Squirrel.* Less frequent than the Fox Squirrel. Both Gray and Black found in Kansas.

51. Tamias striatus Linn.—Chipmunk. Striped Squirrel.* Rare. Found along edges of timber beside grain fields.

52. Spermophilus Franklinii Sabine.—Gray Gopher.* Not common.

53. S. tridecem-lineatus Mitchell.—Striped Gopher. Prairie Squirrel.* Frequent.

54. Pteromys volucella Pallas.—Flying Squirrel* Occasional in timber.

55. Cynomys ludovicianus Ord.—Prairie Dog.* Common in western parts of the State. Said by Prof. Mudge to be dying out very fast for some unknown reason.

56. Arctomys monax Linn.—Woodchuck. Ground Hog.* Rare.

HYSTRICIDÆ.

57. Erethizon dorsatus var. epizanthus Brandt.—Porcupine. Allen. Found sparingly in western parts of the State.

LEPORIDÆ.

58. Lepus sylvaticus Schreb.—Gray Rabbit.* Abundant. Destructive to orchards and gardens. Its flesh counted good eating.

59. L. campestris Bach.—Prairie Hare. Allen. Identified in the central parts of the state.

60. L. callotis Wagler.—Jackass Rabbit.* Common in western parts of the State.

DIDELPHIDÆ.

61. Didelphys Virginianus Shaw.—Opossum.* Not rare in eastern parts of the State.

* Specimens marked * in Baker University Cabinet.

OBSERVATIONS ON THE HABITS OF CERTAIN LARVÆ.

By George F. Gaumer, Student in the University of Kansas.

During the past summer I have been considerably interested in the peculiar habits of several larvae which I have undertaken to breed.

About the first of July I found some larvae feeding upon the leaves of the Canadian Moonseed (Menispermum Canadense). These larvae were then about one inch in length. The general color was glossy-black, thickly dotted all over with white. They had concealed themselves by cutting off the leaf-stems and fastening the stems and leaves all together with a silken web. Some of these leaves were green; others, and by far the larger proportion, were dead. I noticed that none of the green leaves were eaten, while the dead ones were ragged from having been eaten.

On the evening of the tenth of July, while collecting moths just after dark in a woody pasture, I chanced to pass through a thicket of Moonseed vines, where I heard a noise as of rain falling on dry leaves. I soon found that the sound was caused by the larvae biting the dead leaves.

Upon a closer examination I found that they were then feeding upon the dried leaves which they had previously prepared. The snapping sound thus made could be distinctly heard at some distance.

During the day the caterpillars reposed in a long tube composed of silk and dried leaves in the middle of the bunch.

Some of these larvae were placed in a glass jar covered with mosquito bar. While there they grew slowly and cut the dried leaves into small pieces and devoured most of them; green leaves were introduced into the jar but remained untouched while green; when dry they were treated as the others.

It was now about the first of September and there was no change, so that I began to despair of abtaining any imagos from them, and did not look at them again until the first week of October, when they had all disappeared except two.

These two had spun a kind of coarse cocoon in the tube mentioned above, and were in this still unchanged. The body was somewhat shorter and thicker than when first taken.

Early in July I obtained from the tomato a very large larva of Sphinx 5-maculata, and placed it in the breeding cage for safe keeping until I should have time to write a description of it. When I came for the larva next morning, it had disappeared. I soon discovered where it went into the ground. I then began to remove the earth very carefully until I came upon what I supposed to be its cell; then digging down upon one side I next removed the upper part of the arch with a sharp knife.

The cell was then very little larger than the insect's body. The caterpillar was busily engaged working around the sides of its cell with its head. Every few moments it would contract the length of its body and in this way force out the soft earth. It then closed the opening which I had made in the cell. A few minutes later I again opened the cell and found it considerably enlarged, and the caterpillar carefully working around the sides with its jaws, and at the same time secreting a greenish fluid with which it was moistening the inner surface of its cell. The whole internal surface was now moist and smooth. It again closed the opening and I then left it for several days, when I again opened it and found the cell to be about three

inches in length by one and a half inches in height. The larva had already cast its skin. A few days later the chrysalis made its way through the wall of its cell, which had become very hard, almost like sun-dried brick, leaving a rather small circular opening in the end, and then working its way up through nine inches of soil before it reached the surface.

During the first three weeks of July, a creamy white caterpillar, with a very conspicuous dark green dorsal line, made its appearance upon the willow bushes along the banks of the Wakarusa. It was one and fifteen-sixteenths inches in length, and when alarmed or at rest was coiled up and hung to the edge of a leaf.

Some of these caterpillars were removed to the breeding cage where they grew rapidly, and soon afterward descended and excavated a small pit in which they made a very thick, strong, brown cocoon, nearly as tough as leather; it was very smooth inside, impervious to water and not easily indented. Some weeks later a cocoon was opened and the larva was still unchanged. In this condition the larva still remains, and will most probably so hibernate.

On the second of October I found a large Sphinx larva which was feeding upon the green ash. It was not very active, and ate but little for several days. Thinking that it might soon transform, I took it from the cage and began to describe it. While in the act of measuring it a small white worm forced its way through the skin and stood upright upon the back of the caterpillar; soon, more began to come out, and in twenty minutes there were forty-two of these little parasitic grubs standing up at right angles to the body of the sphnix. In a few minutes these little worms began to double up so that head and tail came together. They then spun a fine, white, silk cocoon, and wove it about as wide as their own diameter; this they completed in two days. The Sphnix larva was alive and able to walk all this time, but did not eat. It died four days later.

Before the second brood of Maple Worms (Anisota rubicunda) had attained their growth, the supply of maple leaves was entirely exhausted, so that the worms were compelled to set out in search of food. At one place on the Wakarusa there is a grove of maples, some of which are very large; near this grove there is an open field which had been freshly ploughed, and was slightly beaten down by the late summer rains.

While crossing this field one morning my attention was called to some maple worms crawling upon the ground at least fifteen rods from the nearest maple tree. After looking about for a few moments I found several specimens five rods or more beyond the first, making the remarkable distance of over twenty rods from the grove. Immense numbers of these larvae must have perished on the Wakarusa and Coal creek bottoms from want of food. After the maple leaves were all gone I frequently found them feeding upon the leaves of the burr-oak.

A few days later, while at the old University building, I was surprised to find hundreds of these larvae ascending Mount Oread from the maple groves in the corners of the lot, a distance of about eighteen rods from the old University. Nor did they stop when they had reached the summit of the hill, but many of them were trying to ascend the building. Curious to know what success they were having, I went to the top and there found three way-worn and sickly-looking worms; one of these was much contracted in length and soon afterward transformed into a chrysalis. These larvae had attained a hight of more than one hundred and fifty feet above the place from which they started.

THE COTTONWOOD LEAF BEETLE.

(Plagiodera scripta Fabr.)

By W. Osburn, Student in the University of Kansas.

Beetles are certainly remarkable for their various methods of obtaining sustenance in the larval state. Some live in the ground, feeding upon the roots of plants, some are wood-borers, and others feed upon decaying animal and vegetable matter; some live upon fruit, some are cannibals, devouring other insects, and others still feed upon the leaves of plants. The last method of obtaining sustenance is characteristic of the Chrysomelidae family of beetles, to which belongs the above species. On July 22, 1875, we discovered Plagiodera scripta in the imago state, its eggs, the young, and full-grown larvae, and the pupae, all upon the same willow bush, so that we are enabled to give quite a full history of its habits and transformations.

The eggs are laid in batches, containing from ten to twenty eggs each, upon the under sides of the leaves. When first hatched the larvae are 0.12 of an inch in length, and black. After the first moult, the head is dark brown and the abdomen dusky. The food plants are the willow and cottonwood. Like the larvae of the Colorado potato beetle, they are voracious feeders, a comparatively small number being sufficient to defoliate a tree of considerable size, and were they as numerous as the noted enemy to the potato vine, the damage done by them would be of no little moment. They eat into the side of the leaf, leaving the stem and veins naked. The first lot of beetles was raised from the willow, entering the pupa July 25th, and emerging July 30th.

On August 12th we captured two litters of larvae upon the cottonwood, which had evidently just hatched, judging from the uneaten condition of the leaves upon which they were found. These entered the pupa August 20th, and came forth perfect beetles August 26th, thus making the time required for their total transformation about fifteen days, and establishing the certainty of at least two broods in a season. The most prominent peculiarity of the larva consists in the white fleshy organs which are thrust out from the tip of the abdomen and from the dark-brown tubercles on the sides of the body. What may be the exact use of these organs, especially of those upon the sides of the body, we are unable to tell. They find an analogy in the organs of the Ajax butterfly (Papilio Ajax), and the Asterias butterfly (Papilio Asterias). Like the organs of these butterflies, they give forth a strongly-scented secretion, and from this we might infer that they were a means of defense. One thing is certain, however, that the organ from the abdomen is made use of in pupation, for, this being extended, it is glued fast to the under side of some twig. The larva then only partially sheds its skin, one-fourth of the body remaining within the old skin, to which it is stuck fast. Thus, like the chrysalides of many butterflies, the pupae remain suspended until the imagos come forth. The following are descriptions of three of the different stages of the insect:

Egg.—Length, 0.06 in. Diameter, 0.015 in. Elliptical in shape, and transparent green in color.

Larva.—Length, 0.50 in. Circumference, 0.35 in. Head dark brown, circular, and much smaller than the body. General color of body light yellowish brown; feet dark brown, with an encircling band of light brown near the base; a convexo-concave patch of dark brown on the top of the first

thoracic segment; a short tuberculous spine of dark-brown on each side of the second and third thoracic segments, from which is projected a white, fleshy organ; a sub-dorsal row of dark brown spots, two spots to each segment in the second and third thoracic segments and one in the remaining segments, the spots of the two rows uniting in the eleventh, twelfth, and thirteenth segments and forming one oblong spot; below this, extending from the fifth segment to the last, is a row of dark brown tubercles, one tubercle to each segment; a lateral row of dark brown spots, one spot to each of the last nine segments, below which is a row of dark brown tubercles, one tubercle to each segment, except the second and third thoracic, which have two each; below the latter are two rows of dark brown spots, one spot to each segment, and finally a ventral row of dark brown elongated spots, one to each segment; abdomen provided with a white, viscid, fleshy organ, capable of being extruded.

Pupa.—Length, with the old skin of the larva, 0.50 in. True length, 0.31 in. General color, light brown; head, centre of thorax, and feet, dark brown.

THE ROCKY MOUNTAIN LOCUST.

(Caloptenus spretus Uhler.)

By Prof. F. H. Snow.

Now that this scourge of vegetation has taken its departure, I desire to put upon record a few observations of the past two months.

Upon the sixth of April I discovered the first young locusts, upon the southern slope of Mount Oread, just beyond the limits of the city of Lawrence (latitude 38° 58′; longitude 95° 16′.) This elevation is the termination of the high prairie, forming one of the bluffs at the intersection of the valleys of the Kansas and Wakarusa rivers. When first observed, the young locusts in myriads were at rest upon the ground, some of them, however, feeding upon the leaves of the Indian Plantain (Cacalia tuberosa). They were very diminutive in size, and when disturbed by my walking among them, would hop only two or three inches high, looking very much like the grains of sand in rapid motion upon a vibrating acoustic plate. The hatching took place, I soon learned, not only on the slopes of the bluffs, but also in many spots in the "bottom" land, along roadsides and in fields of grass and grain. It was two weeks after the first hatching of the Mount Oread colony that Mr. W. Osburn caught one hundred and ninety individuals at one sweep of the hand.

Not until about the tenth of May did the young locusts begin to move from their hatching grounds and cause serious apprehension among the farmers for the safety of their crops. At this time combined and systematic effort in neighborhoods infested would have prevented a large portion of the destruction which ensued. By the twentieth of May it became evident that the various colonies of locusts would consume everything in the line of their march and that their ravages would only be arrested by their departure upon gaining their wings. Even at this late day, however, many were able to save portions of their crops by the ditching process. By this method

three determined farmers uniting their efforts, destroyed three hundred and twenty bushels of locusts by actual measurement in ten days' time. On the twenty-fifth of May the destroying armies were entering the city of Lawrence in all directions, and soon the desolation of gardens was almost complete. In two days beautiful lawns of blue-grass were transformed into desert spots, as if they had been subjected to the burning heats of a long and rainless summer. The leaves upon the trees, however, did not share the general destruction, as the wingless gluttons could easily be kept from ascending. One citizen, by persistent combat, successfully defended his beautiful grounds, destroying in six days some seventy bushels of locusts. About one-sixth of the city, between the principal (paved) business street and the river, was not reached by the invading hordes, as was the case with occasional farms in the surrounding country.

In order to obtain a more correct idea of the immense numbers of the locusts, on the first of June I caught upon my own premises, in a common butterfly-net one-half bushel in one-half hour. One quart of these contained, by actual count, 4,000 individuals, or at the rate of 128,000 to the bushel. Five days later, June sixth, they had nearly doubled in size, as one quart contained only 2,100 specimens, these being full grown pupae, just ready to pass into the "imago" form.

The first winged locust was seen on May thirtieth, its final transformation having been carefully watched in the University building. This gives a period of fifty-five days from the first appearance of the larva to the first observed "imago." The winged locusts were first seen to rise, for final departure, on the third of June. By the twelfth of June, just two weeks from the time the last moult commenced, very few remained in the pupa condition. Today, June fourteenth, nearly all have taken their flight from my garden, a few stragglers only remaining behind, generally unable to fly on account of imperfect wings.

The direction of their flight I have carefully noted. When the wind is strong they fly with the wind. If the wind is light they fly towards the northwest, by what appears to be a natural instinct. Thus on June seventh, with a southwest wind, moving according to the University anemometer, at the rate of three miles an hour, the locusts were flying in vast numbers in a direction a little to the north of west, nearly in the face of the wind. On June twelfth, also, with a northeast wind blowing at the rate of four miles an hour, they were flying in greater numbers than ever before in a northwest course, at right angles to the direction of the wind. It is therefore my belief that the natural instinct of the winged locusts of the spring hatching is to move towards the northwest, and though they may be temporarily delayed by contrary gales, that they will sooner or later with ranks decimated by weakened constitutions and by the ravages of birds and parasites, arrive at their natural home in the mountains. It is even possible that none may live to reach the original home of the species. I do not consider the Eastern States to be in any danger from a locust invasion. I have observed hundreds of winged locusts fall to the ground during flight, either already dead or soon dying. These, upon examination, have generally proved to contain no parasites, and I judge that their death was in consequence of impaired strength, this second generation raised in an unnatural climate not equalling in vitality the first generation and succumbing to the fatigue consequent upon extended flight.

In regard to the natural enemies of the locust, I have observed a little external red parasite under the rudimentary wings of the pupa, and sometimes upon the body and secondary wings of the imago. These are mites, of

the same class of insects as the spiders, and are not eggs as some have supposed. They occur in numbers from one to a dozen upon a single locust, and suck the life fluid from its body. Placing about one quart of the locusts by themselves in a breeding cage, June fifth, I bred from them, within two weeks, some twenty specimens of parasitic flies belonging to three different species. One of these was the common Flesh-fly (Sarcophaga carnaria), and the other two were of the genus Tachina, the species not yet determined. I have also discovered several specimens of the Spined Soldier-bug (Arma spinosa), each with its jointed beak inserted in a locust of more than double its own size, and not leaving its victim until life was entirely extinguished. The large fly commonly termed the Bee-killer (Asilus), has been seen destroying the locusts in considerable numbers. Spiders have aided in the work of exterminating the pest. Finally, I am able to offer scientific proof that at least seven species of birds feed upon the locusts, having found them in the gizzards of the Red-headed Woodpecker (Melanerpes erythrocephalus), Yellow-billed Cuckoo (Coccyzus Americanus), Cat-bird (Mimus Carolinensis), Red-eyed Vireo (Vireo olivaceus), Great-crested Flycatcher (Myiarchus crinitus), Crow Blackbird (Quiscalus versicolor), and Blue-bird (Sialia sialis).

The preceding account being based entirely upon personal observations of the writer at his own home, it must not be inferred that the ravages of the locusts have been equally severe in the whole State of Kansas. The destruction by these pests for the year 1875 has been confined to a narrow strip on the eastern border of the State. Kansas, as a whole, never had finer promise of bountiful crops than at the present time, and a second planting will undoubtedly repair the damage in the desolated district. The departure of the locusts is taking place more than two weeks earlier than at the time of the first visitation, eight years ago.

Lawrence, Kansas, June 20, 1875.

LARVA AND CHRYSALIS OF THE SAGE SPHINX.

Sphinx lugens Walker (eremitoides Strecker).

By Prof. F. H. Snow, of the University of Kansas.

During the last days of September, 1873, large numbers of caterpillars not observed in former years, were found feeding upon the leaves of the two species of wild sage which grow abundantly in this region. Some of these being transferred to breeding cages, they in a few days entered the ground, and in May and June, 1874, I obtained from them the moth whose name appears at the head of this article. As the larva and chrysalis of this species have been hitherto unknown, I append the following descriptions:

Larva: Length, 3½ inches; diameter of central segments, .56 inch. Head greenish brown with a conspicuous white stripe on each lateral margin of the front, separating it from the brownish black sides of the head. The first three segments are of a light smoky green, thickly sprinkled with minute white dots, and having a dorsal brownish-black longitudinal band which tapers to a point at the front of the second segment, and enlarges to half its former breadth upon the rear of the first segment, tapering again to a nar-

row white-centered line at the front of this segment. This dorsal band is bordered with white on each side and is not continued beyond the third segment. Color of the remaining segments (except the last which is smoky brown with white dots), light green both above and below, with eight transverse rows of minute brownish-black, incomplete annuli upon each segment. Each of these segments has an oblique white lateral stripe extending from the anterior margin of the stigma to nearly the middle of the adjoining segment, becoming obsolete as it reaches the dorsal surface, except the seventh and last stripe, which remains distinct until it reaches the caudal horn. Each of these white stripes has an obscure blackish border on its upper margin. The white stripe is faintly indicated on the anal segment which is inferiorly margined with white. Caudal horn deep brownish black, .37 inch in length. Stigmata yellowish brown encircled with black, bounded inferiorly with an obscure white line. True legs of a smoky color with silvery spots on the inner surface; prop-legs deep smoky brown, lighter on the inside and with the clasping edges black.

Some of the larvae have the smoky brown markings very obscurely indicated, the prevailing color being pale green.

Food Plants: Salvia trichostemmoides Pursh, and Salvia Pitcheri Torrey.

The larva becomes full grown from the first to the fifteenth of October, and forms its chrysalis in the ground at the depth of five to six inches.

Chrysalis: Length, 2.30 inch; breadth, 0.60 inch; color reddish brown, darker at the anal extremity, upon the upper surface and around the stigmata; an olive tinge upon the breast. The tongue case is 1.12 inch long from the end of the loop to the tip, and is strongly arched, being separated from the body 0.22 inch near its base and just touching the breast at its tip.

The imago appears from May fifteenth to June fifteenth.

Lawrence, Kan., Oct. 1, 1875.

CATALOGUE OF THE LEPIDOPTERA OF EASTERN KANSAS.

By Prof. F. H. Snow, of the University of Kansas.

The following preliminary catalogue of the butterflies and moths of Kansas includes no species with which the writer has not made a personal acquaintance. With the exception of twenty of the moths, all the species are represented in the collections of the University of Kansas, having been taken within five miles of Lawrence, in Douglas county, thirty miles west of the Missouri river. In order to make this list of some practical value to our fruit-growers, farmers, and students of natural history, brief descriptions and notes are given, and the food plant of each species is stated when known. From the notes it will be seen that this order of insects is not composed of mere harmless creatures, without claim to attention and study except for their marvelous beauty of ornamentation. Each species has its peculiar food-plant, upon which it feeds with great voracity during the entire period of its existence as a "larva" or caterpillar. In the "imago," or perfect condition, the Lepidoptera feed chiefly upon the nectar of flow-

ers, doubtless performing an important part in their fertilization, and are entirely harmless except as depositing eggs for new broods of caterpillars. The question whether a given species is injurious to mankind will depend entirely upon the value of its food-plant. In the majority of cases, by "chasing a butterfly" and destroying it, one would render a service to humanity in the prevention of injury to some valuable crop.

Substantial aid in making collections has been rendered by students of the University, among whom special mention should be made of Mr. Geo. F. Gaumer. Thanks are due to Mr. W. H. Edwards, of Coalburgh, West Virginia, for valuable aid in the determination of the butterflies, which include the first eight families. Other acknowledgments will be made in their appropriate places.

Family I.

PAPILIONIDÆ; SWALLOW-TAILS.

This family, named from the unusual length of the tips of the hind pair of wings, is represented by six species, all belonging to the genus.

PAPILIO LINNÆUS.

(Each species with a crimson or orange spot on the inner margin of the hind wings.)

1. Philenor Linn.—Black, with bluish-green metallic lustre upon the hind wings. Expands 3½ to 4¼ inches. Comparatively rare; the caterpillar feeds on the Virginia snakeroot and two other species of the genus Aristolochia. The fact that these plants are not indigenous in this locality, and are but rarely cultivated in gardens, accounts for the scarcity of this butterfly.

2. Asterias Drury.—Black, with two rows of yellow spots along the margin of each wing; expands 3½ to 4½ inches. Abundant; the caterpillar, which is greenish-yellow with black stripes and spots, feeds voraciously upon the foliage of parsnip, carrot, celery, and other umbelliferous plants.

3. Troilus Linn.—Very rare; only two specimens taken. Its chief food-plant, sassafras, has not yet been discovered in this vicinity; it also feeds upon the lilac and the spice bush.

4. Turnus Linn.—Yellow, with broad, black margins and transverse black bands; expands 3½ to 4¾ inches; quite common. Its larva feeds upon the foliage of the apple, wild plum, wild cherry, white ash, tulip tree and wild thorn.

4a. Glaucus Linn.—A black dimorphic female form of Turnus, common here. But one yellow female has yet been taken.

5. Cresphontes Cramer.—Black, with two broad bands of yellow spots, one of which crosses the base of the hind wings; expands 4½ to 5¼ inches. Common in 1873 and 1874; rare in 1871, 1872 and 1875; feeds upon the prickly ash and the hop-tree in this region—upon the orange tree in the Southern States.

6. Ajax Linn.—Pale black, with bluish white bands and spots; expands 2½ to 3¼ inches. Abundant; feeds on the pawpaw. There are three varieties:

a. Var. Marcellus Bois. with tails an inch long.

b. Var. Walshii Edwards, of smaller size and with tails only half an inch long. Of this variety the sub-variety Abbotii Edwards also occurs.

c. Var. Telamonides Felder, intermediate in size between a. and b.

Family II.

PIERIDÆ; WHITE OR SULPHUR BUTTERFLIES.

PIERIS SCHRANK.

7. protodice Bois.-Lec.—Southern Cabbage Butterfly. White, with pale black spots; the male with more white than black, the female with more black than white; expands two inches; becoming more common every year. This species is very destructive to cabbages; in the neighborhood of our chief towns it is often impossible to find a perfect head in cabbage fields of large size, the loss amounting annually to thousands of dollars.

8. vernalis Edwards.—Not uncommon in April; similar in appearance to protodice, but smaller, and with dark lines along the veins of the secondaries underneath. Food-plant unknown, being doubtless some plant of the mustard family (Cruciferae.).

ANTHOCARIS BOISDUVAL.

9. Olympia Edwards.—White, with dusky markings and delicate violet reflections; expands fully 1½ inches. Exceedingly rare. Food-plant unknown. This species is represented in but two or three collections in the United States.

NATHALIS BOISDUVAL.

10. Iole Bois., var. Irene Fitch.—Abundant. The smallest species in this family; expands one inch; sulphur-yellow with black markings.

CALLIDRYAS BOISDUVAL.

11. Eubule Linn.—Rare. Bright sulphur-yellow; expands 3 inches.

COLIAS FABRICIUS.

12. caesonia Godart.—Sulphur-yellow, with broad black irregular margins and pink fringes; expands 2½ to 2¾ inches; abundant; feeds upon clover.

13. Eurytheme Bois.—Orange-yellow, with black margins; expands 2 to 2½ inches; abundant.

14. Philodice Godart.—Sulphur-yellow, with black margins; expands 2¼ to 2⅝ inches; common; two brooded; feeds upon clover and peas.

TERIAS SWAINSON.

15. Nicippe Cramer.—Deep orange-yellow with black margins; expands two inches. Common; food-plants—clover and cassia.

16. Mexicana Bois.—Light sulphur-yellow, with irregular black margins; expands 1½ to 1¾ inches. Not seen in former years, but appearing in abundance during the first week in November, 1875.

17. lisa Bois.-Lec.—Sulphur-yellow with black margins; expands 1⅜ to 1½ inches. Common; feeds upon the "partridge pea," (Cassia Chamaecrista).

Family III.

DANAIDÆ.

DANAIS LATREILLE.

18. Archippus Fabr.—The Archippus Butterfly. Tawny-yellow, with

black and white markings; expands 4 inches; very abundant; sometimes appears in vast flocks in spring, having survived the winter in the "imago" or perfect state. The great abundance of this species may be accounted for by the fact that it has few enemies. The odor and taste of the caterpillar are so offensive that no bird will touch it. Fortunately it feeds upon milk-weed, and is harmless.

Family IV.

NYMPHALIDÆ.

EUPTOIETA DOUBLEDAY.

19. Claudia Cramer.—Pale tawny, with blackish lines; expands 2⅝ inches. Abundant; feeds upon violet, passion-vine, May-apple and purslane.

ARGYNNIS FABRICIUS.

20. Idalia Drury.—Tawny and black with white spots; expands 3⅝ to 4⅛ inches. Common; food-plant wild violet.

21. Cybele Fabr.—Tawny, with black markings; many silvery spots underneath; expands 3¼ to 3¾ inches. Common; feeds upon wild violet.

22. Aphrodite Fabr.—Like the preceding, but darker underneath; very rare; only one specimen taken; feeds upon violets.

MELITÆA FABRICIUS.

23. phaeton Drury.—A single specimen. Feeds upon honeysuckle and lhelone.

PHYCIODES HUBNER.

24. Nycteis Doubl.—Common; feeds upon wild sunflower and Actinomeris.

25. Ismeria Bois-Lec. |Carlota Reakirt.) Common; feeds upon wild sunflower.

26. Tharos Drury.—Abundant; feeds upon the various species of asters, as recently discovered by Mr. T. L. Mead, of New York.

27. Phaon Edwards.—Rare; not before found so far north.

GRAPTA DOUBLEDAY.

28. interrogationis Fabr.—Semicolon Butterfly. So called from the two silver spots beneath each hind wing. Common. Color fulvous with black spots and a narrow purple-gray margin; expands 2½ to 2¾ inches. Feeds upon elm, bass-wood, hackberry, nettle and the hop-vine, often cutting off the entire produce of the latter. Two varieties occur in about equal numbers:

a. Var. umbrosa Lintner; markings of hind wings obscured.

b. Var. Fabricii Edwards; markings of hind wings distinct.

These two forms have been bred from the same set of eggs by Mr. W. H. Edwards of Va.

29. comma Harris.—The Comma Butterfly. With a single curved silver spot under each hind wing; expands 2⅛ to 2⅓ inches; not common; feeds upon elm, nettle and the hop vine. As in the preceding species, two varieties occur, both bred from the same set of eggs, by Mr. Edwards.

a. Var. Harrisii Edwards; distinctly marked on hind wings.
b. Var. Dryas Edwards; hind wings obscure.

VANESSA FABRICIUS.

30. Antiopa Linn.—The Mourning Cloak. Brownish black, with yellow margins preceded by a row of blue spots; expands 3⅛ to 3½ inches. Not common; feeds on the willow, poplar, elm and hop; is often very destructive elsewhere.

PYRAMEIS HUBNER.

31. Huntera Fab.—Hunter's Butterfly. Expands 2 to 2¼ inches; has two eye-spots under each hind wing; common; feeds upon thistle, sunflower, and other wild, coarse plants.

32. cardui Linn.—The Thistle Butterfly. Expands 2½ to 2¾ inches; has five eye-spots under each hind wing. Abundant; feeds upon thistles, sunflowers, holly-hock, burdocks, etc.

33. Atalanta Linn.—Brownish black with red band across front wings and red margin upon hind wings; expands 2¼ to 2⅝ inches. Common; the caterpillar feeds upon nettles, and has a peculiar protection from the poisonous prickles of its food plant in the longer prickles with which its own body is covered; also feeds upon the hop.

JUNONIA HUBNER.

34. Lavinia Cramer. Brown, with whitish band enclosing a large eye-spot upon each front wing; two eye spots upon each hind wing; expands 2 to 2¼ inches; feeds upon plantain and toad-flax; common.

LIMENITIS FABRICIUS.

35. Ursula Fabr.—Black, with a bluish tinge which deepens upon the hind wings, expands 3 to 3½ inches. Not common; feeds on the gooseberry, apple, quince, plum, oak, hornbeam, hawthorn, willow and wild cherry.

36. misippus Fabr.—Similar in color to the Archippus butterfly, but with a narrow black band across the hind wings; expands 3 to 3⅝ inches. Common; feeds on the cottonwood, apple, oak, poplar, plum and willow. This species and the preceding are remarkable among butterflies for hibernating in the caterpillar state. The marked resemblance between this species and No. 18, furnishes an illustration of so-called "protective mimicry."

APATURA FABRICIUS.

37. celtis Bois.-Lec.—Grayish-brown, with white and black spots; eight eye-spots under each hind wing (one double); expands 2 inches. Common; feeds upon the hackberry.

38. clyton Bois.-Lec.—Tawny brown; seven eye-spots under each hind wing; expands 2 to 2¾ inches. Rare; feeds upon the hackberry.

PAPHIA WESTWOOD.

39. glycerium Doubl.—Copper red; expands 2⅝ to 3 inches. Common; feeds upon the two species of goatweed found in this region (Croton capitatus and C. monanthogynus). The two sexes differ so much in coloration as to be easily mistaken for distinct species. This species is double brooded and hibernates in the imago condition.

Family V.

LIBYTHEIDÆ.

LIBYTHEA FABRICIUS.

40. Bachmanii Kirtland.—Snout butterfly; brownish-black with white

and tawny markings; palpi elongated, forming a conspicuous "snout;" rare formerly, but common in 1875.

Family VI.

SATYRIDÆ.

The members of this family are grayish to blackish brown in color and have eye-spots both above and below.

EUPTYCHIA HUBNER.

41. eurytris Fabr.—Rare; has two eye-spots upon each wing; expands 1½ inches; feeds upon grasses.

SATYRUS WESTWOOD.

42. Alope Fabr.—Has a yellow patch upon each front wing enclosing two brown spots; expands 2⅛ to 2¾ inches. Common; feeds upon grasses.

43. Nephele Kirby.—Of a darker brown color. Common; feeds upon grasses; possibly a variety of the last.

LETHE HUBNER.

44. Portlandia.—Not common; feeds upon grasses; expands 2⅛ to 2⅜ inches.

Family VII.

LYCAENIDÆ; AZURE-BLUE AND COPPER BUTTERFLIES.

THECLA FABRICIUS.

45. humuli Harr.—Hop-vine Thecla. Dark blue-gray, with small orange spot and short tails upon tips of hind wings; expands 1 to 1⅛ inches. Common; feeds upon the heads of hops.

46. calanus Hubner.—Rare; feeds upon wild thorn (Crataegus).

47. strigosa Harris.—Rare.

48. Mopsus Hubner.—Rare; feeds upon thoroughwort (Eupatorium).

49. Irus Godart.—Rare; a pair taken in April, 1875.

FENISECA GROTE.

50. Tarquinius Fabr., Var. Porsenna Scudder.—Exceedingly rare; a single specimen was taken by Geo. F. Gaumer in July, 1873.

CHRYSOPHANUS HUBNER.

51. Hyllus Cramer.—Rare; food plant unknown.

52. Dione Scudder.—Not uncommon in 1875.

LYCÆNA FABR.

53. comyntas Harr.—Abundant; feeds upon bush-clover (Lespedeza and Desmodium.

54. isola Reakirt.—Common.

55. pseudargiolus Bois.-Lec.—Common; bred by Mr. W. H. Edwards from Actinomeris.

Family VIII.

HESPERIDÆ; SKIPPER BUTTERFLIES.

The members of this family have hooked antennæ; except Nisoniades, they feed upon grasses; one or two species also have other food-plants.

EPARGYREUS HUBNER.

56. tityrus Fabr.—Brown, with yellowish tinge; an interrupted yellowish band across each front wing, and a large satin-white spot beneath each

hind wing; expands 1¾ to 2⅛ inches. Common; feeds upon the common locust tree (Robinia pseudacacia), and rose-acacia (Robinia hispida).

THORYBES SCUDDER.

57. bathyllus Abb.-Sm.—Abundant.
58. Pylades Scudder. Rare.

NISONIADES HUBNER.

59 juvenalis Fab.—Common. Feeds upon oak and English filbert.
60. Martialis Scudder.—Common.
61. Brizo Bois.—Rare.
62. Horatius Scudder.—Not uncommon; a near ally of juvenalis, perhaps only a variety of that species.

PHOLISORA SCUDDER.

63. catullus Fabr.—Abundant; feeds upon pigweed.
64. Hayhurstii Edwards.—Rare; only three specimens taken.

HESPERIA FABRICIUS.

65. tessellata Scudder.—Gray-black with many small rectangular white spots; expands 1¼ to 1½ inches. Abundant.

ANCYLOXYPHA FELDER.

66. numitor Fabr.—Not common; this and catullus are the smallest species in this family, expanding only one inch.

ATRYTONE SCUDDER.

67. Iowa Scudder.—Common.
68. Delaware Edwards.—Rare; one specimen taken by G F Gaumer.
69. Kumskaka Scudder Mss.—Rare; two specimens taken.
70. Hobomok Harris.—Rare.

EUTHYMUS SCUDDER.

71. phylæus Drury.—Rare in former years; common in 1875.

ATALOPEDES SCUDDER.

72. Huron Edwards.—Abundant.

ANTHOMASTER SCUDDER.

73. Leonardus Harris.—Rare.

POLITES SCUDDER.

74. Peckius Kirby.—Rare.

LIMOCHORES SCUDDER.

75. cernes Bois.-Lec.—Common.

EUPHYES SCUDDER.

76. Metacomet Harris.—Rare.
77. verna Edwards.—Rare.

Family IX.

SPHINGIDÆ; HAWK MOTHS.

The members of this family have been termed Crepuscular Lepidoptera to distinguish them from the diurnal and the Nocturnal Lepidoptera. They fly about flowers, chiefly at dusk, and in their movements bear no little resemblance to humming-birds. In the arrangement of species I have followed the monograph of Dr. Brackenridge Clemens. Twenty-seven species are known to occur in Kansas, twenty-three of which have been taken at

Lawrence; the four remaining species were taken at Leavenworth and Tonganoxie, by Dr. W. B. Carpenter and Mr. T. B. Ashton.

SESIA FABR. CLEAR-WINGED SPHINGES.

78. axillaris Grote.—Wings transparent except on margins; expands 1½ to 1⅞ inches; common.

79. Thysbe Fabr.—Colors olive-green and rich brown; wings transparent in centre; expands 2¼ inches; rare, only one specimen taken.

THYREUS SWAINSON.

80. Abbotii Swainson.—The Abbott Sphinx. Brown, basal half of hind wings yellow; expands 2½ to 3 inches. Rare; feeds upon both wild and cultivated grape, and upon the woodbine.

81. Nessus Cramer.—Brown, with two narrow transverse bands upon the abdomen. Rare.

DEIDAMIA CLEMENS.

82. inscripta Harris.—Grayish-brown; expands 1⅞ to 2¼ inches. Rare. Feeds upon sour-wood.

DEILEPHILA OCHSENHEIMER.

83. lineata Fabr.—White-lined Morning Sphinx. A whitish band from base to tip of each front wing; a broad red band across each hind wing; expands 3½ inches; feeds upon purslane and turnip; when in confinement will eat apple leaves. This species flies by day, and is very abundant.

DARAPSA WALKER.

84. Chœrilus Cramer.—Reddish-brown, with fawn color upon the front wings; expands 3¼ inches; said to feed upon Azalea, a plant not found in Kansas. Rare, only one specimen.

85. Myron Cramer.—Front wings pale green with a darker band of same color; hind wings rust-red; expands 2¼ to 2½ inches. Very destructive to the foliage of the grape, sometimes also detaching clusters of the fruit. Abundant. Mr. Riley has named the larva the "Hog-caterpillar of the vine."

CHOEROCAMPA DUPONCHEL.

86. Tersa Linn.—Front wings greenish-brown; hind wings black with marginal row of yellow spots; expands 2¾ to 3 inches. Rare, only one taken.

PHILAMPELUS HARRIS.

87. Satellitia Linn (Pandorus Hubner).—The Satellite Sphinx. Variegated with light green and olive; a light reddish patch at the inner angle of the hind wings; expands 4 to 4½ inches; feeds upon the grape vine and the woodbine. Rare.

88. Achemon Drury.—Fawn color with three dark-brown patches upon each front wing; hind wings deep pink with broad brownish margin; expands 3¼ to 4 inches; feeds upon the grape vine. Not common.

89. labruscæ Linn.—Front wings green; hind wings blue with black transverse bands; expands 4½ inches. Very rare, one specimen taken at Leavenworth by Dr. W B Carpenter.

MACROSILA WALKER.

90. cingulata Linn.—Gray, with bases of hind wings and five spots upon each side of the abdomen deep rose-red; expands 4⅝ inches; feeds upon the sweet potato. Rare.

91. Carolina Linn.—The Tobacco-worm Moth. Dark gray with five orange spots on each side of the abdomen, and obscure wavy black lines across the hind wings; expands 4 to 5⅛ inches; feeds upon the tobacco plant; also upon the tomato. Common.

92. quinquemaculata Stephens.—The Potato-worm Moth. Almost identical in appearance with the last species, but with the markings of the hind wings distinct; expands 5 to 5½ inches; feeds upon potato and tomato. Common.

SPHINX LINN.

93. eremitus Hubner (sordida Harr.)—Dark gray with two whitish bands upon the hind wings; expands 2⅝ to 2¾ inches. Not common.

94. lugens Walker (eremitoides Strecker).—The Sage Sphinx. Of a lighter gray than the last species; expands 2⅞ to 3¾ inches; common; feeds upon our two species of wild sage (Salvia trichostemmoides Pursh. and S. Pitcheri Torrey).

95. drupiferarum Abb. and Sm.—Front wings blackish-brown, with basal portion of anterior margin and band along outer margin, whitish; hind wings whitish, with two black bands; expands 4 to 4¾ inches; feeds upon the plum and the hackberry; rare.

ANCERYX WALKER.

96. Ello Linn.—Gray except hind wings which are rust red with broad blackish terminal margins; expands 3½ inches; rare, two specimens taken by Dr. Carpenter, at Leavenworth.

DOLBA WALKER.

97. hylœus Drury.—Dark brown with white and black markings; two blackish bands across hind wings; expands 2¼ inches; not common; taken at Leavenworth by Dr. Carpenter and at Tonganoxie by T. B. Ashton. Feeds upon papaw.

CERATOMIA HARRIS.

98. quadricornis Hubner (Amyntor).—The Elm Sphinx. Dull brown varied with black; expands 4 to 4¾ inches; feeds upon the elm; rare.

99. repentinus Clemens (undulosa Walker; Brontes Drury).—The Ash Sphinx. Pale ash color, with three narrow wavy black bands crossing hind wings; expands 4 inches; feeds upon the ash and lilac; not common.

SMERINTHUS LATR.

100. Myops Abbot and Smith.—Front wings chocolate brown, hind wings pale yellow; expands 2½ inches; feeds upon the wild cherry. Rare, taken by T. B. Ashton at Tonganoxie.

101. excæcatus Abb. and Smith.—The Blind Smerinthus. Fawn color with brown patches; hind wings rose red in the center with a black, blue-pupiled eye-spot; expands 2½ to 3⅜ inches; feeds upon apple, wild rose and maple; not uncommon.

102. modesta Harris.—The front wings are pale gray with a darker broad central olive-brown band; hind wings purplish red with bluish spot at inner angle; expands 4½ to 5 inches; rare; feeds upon the Lombardy poplar, and other poplars.

103. geminatus Say.—Front wings gray with rosy tinge and dark brown markings; hind wings rose red with a black eye-spot having two blue pupils; expands 2¼ to 3 inches; rare; feeds upon willow.

104. juglandis Abb. and Sm.—Pale gray or fawn color with darker bands and spots; hind wings with a light central band margined with dark

lines; expands 2¼ to 3 inches; common; feeds upon walnut, iron-wood and hickory.

Family X.

ÆGERIADÆ: THE AEGERIANS.

ÆGERIA FABRICIUS.

105. exitiosa Say.—The Peach-tree Borer. The greatest enemy of the peach-tree. The male moth has all the wings transparent and expands one inch; the female has the front wings bluish black, the hind wings transparent and an orange band across the middle of the abdomen. The larva bores in the outer wood of the trunk of the tree near the ground, sometimes descending into the root. This species also occasionally attacks plum and cherry trees. Abundant, often destroying whole orchards.

106. cucurbitæ Harris.—The Squash-vine Borer. Similar in size and appearance to the preceding, but with nearly the entire abdomen and the hind legs of a deep orange color. The larva bores into the stem of the squash, and other vines of the melon family, near the root, and causes them to suddenly wilt and die. Five specimens are in the cabinet, taken by G. F. Gaumer.

107. tipuliformis Linn.—The Currant Borer. Bluish black; wings transparent except the black margins; three narrow yellow rings on abdomen (four in the male); expands ¾ inch. Very destructive to currant bushes, boring in the pith; common.

108. Ægeria sp.—An undetermined species; taken by Mr. Gaumer upon the flowers of the button-bush (Cephalanthus). Six narrow yellow bands upon the abdomen; expands .80 inch. Quite common.

Family XI.

ZYGÆNIDÆ.

ALYPIA HUBNER.

109. octomaculata Fabr.—The Eight-spotted Forester. Black with two pale yellow spots on each front wing and two white spots on each hind wing; expands 1⅜ to 1⅝ inches. Becoming common; very destructive to vineyards in Douglas county in 1875, in some cases completely defoliating the vines and cutting off the crop.

PSYCHOMORPHA HARRIS.

110. epimenis Drury.—The grape-vine Epimenis. Black, a white spot on each front wing; expands .9 to 1.1 inch; feeds upon the tender leaves of the grape in early spring; not yet so common and destructive as the last species.

EUDRYAS BOISDUVAL.

111. grata Fab.—The Beautiful Wood-nymph. Front wings white, hind wings yellow, all the wings with dark red margins. Feeds upon the grape vine; rare, only two specimens taken. The larvæ of this and the two preceding species have been called by Mr. Riley the "Blue Caterpillars of the vine"; they are very similar in appearance, being of a bluish color with many narrow transverse black stripes.

GLAUCOPIS LATREILLE.

112. fulvicollis Hubner.—Smoky black, with orange head and collar; hind wings partly transparent; expands 1¼ inches; common.

Family XII.

BOMBYCIDÆ; SILK-WORM FAMILY.

The seventy-five species in this family are arranged according to Dr. A. S. Packard's Synopsis.

HYPOPREPIA HUBNER.

113. fucosa Hubner.—Deep pink, with smoky markings; expands 0.9 to 1.1 inches; not common.

CRAMBIDIA PACKARD.

114. pallida Packard.—Uniform drab; expands ¾ inch; not common.

EUSTIXIS HUBNER.

115. pupula Hubner.—White, with black dots upon front wings; expands 0.6 inch; one specimen.

EUPHANESSA PACKARD.

116. mendica Walker.—Wings nearly transparent, but with a yellowish tinge; smoky spots upon the front wings; expands 1 to 1¼ inches; common in the Wakarusa woods.

CROCOTA HUBNER.

117. Crocota sp.—An undetermined species; of a uniform dull red; expands 1 inch; common.

UTETHEISA HUBNER.

118. bella Linn.—Front wings deep yellow, with five or six white bands enclosing black spots; hind wings bright scarlet with black margins; expands 1½ inches; common; feeds upon the unripe seeds of the "rattle box" (Crotalaria).

CALLIMORPHA LATREILLE.

119. interrupto-marginata Beauv.—Rare; a single specimen taken at Leavenworth by Dr. Carpenter.

120. Lecontei Boisd. (militaris Harr).—The Soldier Moth. White, with front wings margined and crossed with brown bands; expands two inches; common; bred from the "false gromwell" (Onosmodium).

121. vestalis Packard.—White, with front margins of front wings and the legs yellowish; expands 2 inches; rare. Mr. Riley considers this species to be identical with C. fulvicosta Clemens, the larva of which feeds upon young peach leaves in the spring, and is called by him the Blue Spangled Peach-worm.

ARCTIA SCHK.

122. virgo Linn.—Virgin Tiger Moth. Front wings black, with many interlacing stripes of flesh color; hind wings vermilion, with black spots along the margin and in the centre; expands 2⅛ to 2½ inches; rare.

123. parthenice Kirby (Saundersii Grote).—Similar to the preceding, but smaller, also with the black of front wings more restricted, and without black spots in the centre of the hind wings; expands 1.65 inches; abundant; bred by Mr. Gaumer from iron-weed (Vernonia); also by Mr. Saunders, of Canada, from lambs-quarter (Chenopodium).

124. phalerata Harris.—The Harnessed Tiger Moth. Stripes on front wings pale yellow, and fewer than in the preceding; hind wings yellow, tinged with red, with black margins sometimes entire and sometimes broken into spots; expands 1½ inches. Not uncommon.

125. Phylira Drury.—Similar to virgo, but smaller, and without black

spots in centre of hind wings; expands 1½ to 1¾ inches. Not common.

126. decorata Saunders (Nais Drury).—Similar to phalerata, but with the black portion more extended and of a deeper shade. Rare.

127. virguncula Kirby.—Hind wings yellow, with black margins and spots; expands 1⅞ inches. Rare.

128. Persephone Grote.—Similar to the last species, but with broader stripes upon the front wings, and the black margin of the hind wing unbroken. Rare.

129. Arge Drury.—The black of the front wings is almost obliterated by the broad white bands; hind wings white, with a slight reddish tinge, and about six very small black spots near the outer margins; expands 2 to 2¼ inches. Not common. Feeds upon plantain, and is said to cause great destruction to young Indian corn in the Southern States.

PYRRHARCTIA PACKARD.

130. Isabella Smith.—The Isabella Tiger Moth. Tawny, with obscure black markings; hind wings lighter; expands 2 inches; abundant; feeds upon clover, dandelion, and plantain.

LEUCARCTIA PACKARD.

131. acræa Smith.—The Salt-marsh Moth. All the wings white in the female, with small black spots; the hind wings tawny yellow; expands 2 1-5 inches. Quite common; found feeding upon beet leaves by Mr. Gaumer. This species is abundant along the coast, where it is very destructive to the grass in salt-marshes. Its presence here is doubtless due to the abundant salt deposits of Kansas.

SPILOSOMA STEPHENS.

132. Virginica Fabr.—The Virginia Ermine Moth. Pure white, with one black dot upon each front wing, and two upon each hind wing; expands 1½ to 2 inches. Common; devours peas, beans, corn, plantain, grasses, and sometimes grape, currant and gooseberry.

HYPHANTRIA.

133. textor Harris.—The Fall Web-worm or Weaver. Generally pure white, occasionally with black spots; expands 0.9 to 1.4 inches. Abundant from June to September. Spins a web as it feeds, and attacks a great many trees and other plants, especially pear, cherry, apple, Osage orange, and hickory.

ECPANTHERIA HUBNER.

134. scribonia Stoll.—The Great Leopard Moth. White with numerous black rings upon front wings; expands 2½ inches. Rare; feeds upon sunflowers, plantain and willow (Riley).

HALESIDOTA HUBNER.

135. tessellaris Smith.—The Checkered Tussock-moth. Pale yellow, semitransparent wings, the front pair crossed by smoky checkered bands; expands 1¾ to 2 inches. Quite common.

EUCHAETES HARRIS.

136. Egle Drury.—White, with yellowish margin to front wings; expands 1½ to 1¾ inches. Not common; feeds upon the common milkweed.

137. Oregonensis Stretch.—Similar to the preceding but without the yellow margin of front wings.

138. Spraguei Grote.—Slate color, with red margins. Rare; only one specimen.

LAGOA HARRIS.

139. crispata Packard.—Yellowish white, with dusky patches upon each front wing; very woolly; expands 1⅓ to 1¾ inches. Feeds upon the wild blackberry.

EUCLEA HUBNER.

140. pœnvata Clemens.—Front wings green, with brown margins all around; hind wings dingy white; expands one inch. Not common.

PARASA MOORE.

141. chloris H.-S.—Similar to the preceding but without brown upon inner margin. Rare.

EMPRETIA CLEMENS.

142. stimulea Clemens.—Seen only as a larva, which, from its peculiar markings, has been called the "Saddleback" larva. Feeds upon the pear. Rare.

PHOBETRUM HUBNER.

143. pithecium Smith.—The Hag-moth. Seen only as a larva, which has curious fleshy "arms." Rare; feeds upon the crab-apple.

LACOSOMA GROTE.

144. chiridota Grote.—Rare; one specimen, determined for me by Dr. Packard.

ICHTHYURA HUBNER.

145. inclusa Hubner.—Grayish brown, the front wings crossed with whitish lines having a yellowish brown spot near the apex; expands 1⅛ inches. Not common.

146. albosigma Fitch.—Similar in color to the last but with the white lines more distinct, and the apical spot somewhat resembling the letter S; expands 1½ inches. Not common.

DATANA WALKER.

147. perspicua G. and R.—The Sumac Moth. Bright yellowish brown, the front wings margined and crossed by darker brown lines; expands 1¾ to 2 inches. Abundant; double-brooded; feeds upon the common sumac (Rhus glabra).

148. integerrima G. and R.—Purplish brown, with lines as in the preceding; expands 1½ to 2¼ inches. Abundant; feeds upon the black-walnut and hickory.

GLUPHISIA BOIS.

149. trilineata Packard.—Grayish brown, with three transverse lines on front wings; expands 1.15 inch. Not common.

150. Gluphisia n. sp.—Sent to Dr. Packard for determination.

HYPARPAX HUBNER.

151. aurora Smith.—Alternately yellow and rose red; expands 1½ inches. Rare.

NADATA WALKER.

152. gibbosa Smith.—Yellowish brown, each front wing crossed with two dark lines and having two white dots and a bright yellowish red spot near the center; expands 1.8 to 1.9 inch. Not common.

NOTODONTA OCHSENHEIMER.

153. stragula Grote.—Dull brown with reddish brown markings upon front wings; expands 1¾ inches. Rare.

154. Notodonta sp.—Taken by Dr. Carpenter at Leavenworth.

NERICE WALKER.

155. bidentata Walker.—Grayish brown, each front wing with an irregular longitudinal dark brown band, bordered with white; expands 1.6 inches. Rare.

EDEMA WALKER.

156. albifrons Smith.—Grayish brown, each front wing with an irregular whitish band along the outer half of the front margin; expands 1⅜ to 1⅝ inches. Common; feeds upon the oak.

DASYLOPHIA PACKARD.

157. interna Packard.—Taken by Dr. Carpenter at Leavenworth.

COELODASYS PACKARD.

158. unicornis Smith.—Ashy brown, with greenish tinge along front margin of front wings; expands 1⅓ to 1½ inches. Not common.

159. biguttatus Packard.—Front wings brown; hind wings dull white, with smoky margins; expands 1½ inches. Only one specimen.

160. leptinoides Grote.—Dark ashy brown; expands 1.6 inches. Rare, only one specimen taken.

HETEROCAMPA DOUBL.

161. obliqua Packard.—Front wings dark brown, with reddish streaks; two or three oblique white patches near outer margins; hind wings whitish, with brownish margins; expands 2 inches. Rare; taken at Leavenworth by Dr. Carpenter.

162. brunnea G. and R.—One mutilated specimen; expands 2.15 inches.

163. pulverea G. and R.—Ash brown, darker on basal half of front wings; expands 2⅓ inches. Rare.

164. Heterocampa sp.—An undetermined species. Ash brown, with darker shades; expands 1.6 inches. Not common.

LOCHMÆUS DOUBL.

165. biundata Walker.—Dark brown, with small reddish spots; expands 1¾ to 2 inches.

166. unicolor Packard.—The Sycamore Moth. Uniform ash color; expands 1.9 inches. Rare; bred from the sycamore, by W. Osburn.

CERURA SCHRANK.

167. borealis Harr.—Ash color, with darker shades; a row of small dark spots near outer margin of front wings; expands 1⅓ inches. Not common.

168. multiscripta Riley.—A beautiful moth with front wings white, crossed by many wavy black lines; hind wings ash color; expands 1¼ to 1½ inches. Rare; taken by Dr. Carpenter at Leavenworth, and by T. B. Ashton at Tonganoxie.

TELEA HUBNER.

169. Polyphemus Linn.—The American Silkworm. Varying from ash color to yellowish brown, with reddish tinges; a purple and brown narrow band near the margin of each wing; a transparent eye-spot upon each front wing, bordered narrowly with yellow and black; a larger black eye-spot upon each hind wing, with transparent center bordered with yellow, and with blue scales upon the black; expands 4½ to 5½ inches; feeds upon oak, walnut, hickory, basswood, elm, maple, hazel, apple, rose, quince, thorn, plum, choke-cherry, sycamore, poplar, birch, honey-locust and willow (Riley's 4th

Report). Not rare; excellent silken fabrics may be made from the cocoon of this species.

TROPÆA HUBNER.

170. Luna Linn.—Pale green, with front margin of front wings brown, an eye-spot upon each of the four wings, and long tails to the hind wings; expands 4 to 4⅝ inches. Common; feeds chiefly upon black walnut and hickory, sometimes also upon willow and plum.

SAMIA HUBNER.

171. Cecropia Linn.—The largest of all our moths; expanding 5 to 7⅛ inches; general color brown; bases of wings reddish, a reddish white-bordered band crossing all the wings, the white border most conspicuous on the hind wings; a large reniform white and reddish spot at the center of each wing; a black eye-spot enclosing a narrow semicircle of blue, and a violet patch near the apex of front wings. Common; feeds upon apple, cherry, currant, barberry, hazel, plum, hickory, blackberry, elderberry, elder, elm, lilac, red-root, maple, willow, and honey-locust. (Riley's list of food-plants.)

BOMBYX LINNÆUS.

172. mori Linn.—The Chinese Silkworm. White, with faint smoky markings; expands 1 4-5 inches; introduced successfully, feeding upon our native Osage orange as well as upon the mulberry. The frequent cultivation of this species would seem to entitle it to place in a list of Kansas insects.

CITHERONIA HUBNER.

173. regalis Fab.—The Regal Walnut-moth. Front wings olive, with longitudinal red lines and seven or eight yellow spots; hind wings orange, spotted with olive and with yellow bases. Common; feeds upon the black walnut. The green caterpillar is 5 to 6 inches long, with long, yellow, black-tipped spines.

EACLES HUBNER.

174. imperialis Drury.—The Imperial Moth. Yellow with brown bases, a brown central spot and a transverse brown band upon each wing; entire surface sprinkled with brown dots; the male with more brown than the female; expands 4 to 6 inches. Rare; feeds upon button-wood, pine, and oak.

EUCHRONIA PACKARD.

175. Maia Drury.—Buck Moth. Pale black, with a white band crossing each wing; a black, white-centered spot in the white of each wing; expands 2.3 to 3.1 inches. Not common; feeds upon oak, hazel and wild cherry; flies in November; occupies two years in making its transformations.

HYPERCHIRIA HUBNER.

176. varia Walker (Io Harris).—Yellow with a large black white-pupiled eye-spot upon each hind wing, behind which are two narrow bands, a black and a red. In the female the front wings are reddish brown instead of yellow; expands 2⅓ to 3¾ inches. Not common; feeds upon false indigo, wild cherry, willow, poplar, hop-vine and corn.

DRYOCAMPA HARRIS.

177. rubicunda Fabricius.—The Rosy Dryocampa. Front wings rosy red, with a yellowish white band; hind wings yellowish white, with a narrow rosy band; expands 1¾ inches. Rare; one specimen taken at Leavenworth by Dr. Carpenter.

Var alba Grote.—A western race of the preceding but very different in color, the female being generally of an unbroken white, while the males have a mere trace of rosy red upon each wing; expands 1½ to 2⅓ inches. Abundant, causing great destruction to the foliage of the soft maples in 1874 and 1875; the species is two-brooded.

178. bicolor Harris.—Front wings brownish or yellowish gray, with blackish dots; hind wings crimson; expands 2 to 2½ inches. Rare.

ANISOTA HUBNER.

179. senatoria Smith.—Yellow, tinged with purplish and sprinkled with blackish dots; expands 2½ inches. Feeds upon the oak; rare, a single specimen taken at Leavenworth by Dr. Carpenter.

180. pellucida Smith.—Reddish brown, with centers of front wings transparent; expands 1.42 inches. Rare; a single specimen bred from the oak by G. F. Gaumer.

TOLYPE HUBNER.

181. Velleda Stoll.—Pure white, with dusky markings; body woolly; expands 1½ to 2¼ inches. Rare; two specimens taken by T. B. Ashton at Tonganoxie.

CLISIOCAMPA STEPHENS.

182. Americana Harris.—The Tent-caterpillar Moth. Reddish Brown, with two white lines crossing each front wing; expands 1 to 1½ inches. Abundant; feeds upon apple and wild cherry; the eggs are laid in the fall, in bunches of 300 or 400, placed side by side and protected by a gummy secretion; these hatch in the spring and the caterpillars disfigure the trees with their web, often completely defoliating them.

XYLEUTES HUBNER.

183. robiniœ Harris.—The Locust Borer. Black and gray, reticulated; the hind wings in the male have the lower half yellow; expands 2⅓ to 2¾ inches. Common; the caterpillar bores in the locust and red-oak.

Family XIII.

NOCTUIDÆ: OWLET MOTHS.

For valuable aid in the determination of a large proportion of the 213 species in this family, and for many other favors, I am indebted to Mr. A. R. Grote, Director of the Museum of the Buffalo Society of Sciences, of Buffalo, N. Y.

LEPTINA GUENEE.

184. ophthalmica Guenee.—Ash gray, with darker markings; expands .9 to 1.1 inches. Common.

RAPHIA HUBNER.

185. abrupta Grote.—Ash gray, with basal half of front wings nearly black; expands 1 to 1½ inches. Common.

CHARADRA WALKER.

186. deridens Guenee.—Rare; taken at Leavenworth by Dr. Carpenter.

MOMA HUBNER.

187. fallax Herr.-Sch.—Front wings sea-green, with angular black spots; expands 1.40 inches. Rare.

ACRONYCTA OCHSENHEIMER.

The species of this genus are of different ashy shades, with a few

short, black dashes upon the front wings, from which they have been termed Dagger-moths.

188. vinnula Grote.—Rare; expands 1 1-5 inches.

189. grisea (?) Barnston.—Rare; expands 1⅓ inches.

190. morula G. and R.—Rare; expands 2 inches.

191. connecta Grote.—Rare; expands 1¼ inches; feeds upon willow.

192. lepusculina Guenee (Populi Riley).—The Cottonwood Dagger. The ash color very light; expands 1¾ to 2 inches. Common; feeds upon cottonwood and willow.

193. hastulifera Abb. and Sm. (Americana Harris).—The hind wings very dark; expands 2.40 to 2.62 inches. Common; feeds upon maple, elm, basswood and chestnut.

194. rubricoma Guenee.—Rare; expands 1⅝ inches.

195. clarescens Guenee.—Dark hind wings; expands 1.55 inches. Not common.

196. dissecta G. and R.—Common; expands 1.12 to 1.28 inches.

197. xyliniformis Guenee.—Hind wings white; expands 1¾ inches. Rare; feeds upon oak, willow, rose, poison ivy, peach and persimmon (Riley's 5th Report).

198. oblinita Abb. and Sm.—The Smeared Dagger. Front wings relatively narrower than in the other species of this genus; hind wings white; expands 1.50 to 2.10 inches. Common; feeds upon peach, apple, willow, smartweed and button-bush.

JASPIDEA HUBNER.

199. teratophora Herr.-Sch.—One mutilated specimen; expands .90 inch.

LITHACODIA HUBNER.

200. bellicula Hubner.—Gray-brown, with a white triangular spot near the outer margin of each front wing; expands ¾ inch. Common.

MICROCOELIA GUENEE.

201. diphteroides Guen.—Front wings pale green, with black spots and transverse wavy lines; expands 1¼ inches. Common.

AGROTIS HUBNER.

This genus embraces what are termed the Cut-worm Moths, the larvæ being very destructive to field and garden crops, working at night, and cutting off close to the ground the young and tender stems of corn, potatoes, tomatoes, cabbages, etc., etc.

202. badinodis Grote.—Dark brown, with two small square black spots on each front wing; the front wings are unusually broad. Not common.

203. c-nigrum Linn.—Reddish brown, varied with black mark near the centre of each front wing, having a fancied resemblance to the letter C; expands 2 inches. Not common.

204. auxiliaris Grote.—Dark brown, with lighter markings; expands 1.70 to 1.90 inches. Common.

205. tricosa Lintner.—Common; with broader wings than the next species, which it much resembles.

206. subgothica Haworth (jaculifera Riley).—No brief description can distinguish properly this from the preceding species; expands 1½ inches; is very abundant, and very destructive.

207. lubricans Guenee.—Front wings plain brown; hind wings white; expands only 1 1-5 inches. Not common.

208. clandestina Harris.—Dark brown; expands 2 inches. Not common.

209. brunneicollis Grote.—Rich brown, with a narrow black band near outer margin of front wings; collar velvety brown; expands 1½ inches. Not common.

210. cupida Grote.—Very much like the preceding in color and size, but without the dark-brown collar.

211. Cochrani Riley (repentis G. and R.).—The Climbing Cut-worm. Brown, with black circles and wavy bands; expands 1½ inches. Common; climbs fruit trees and destroys the tender buds in spring.

212. saucia Hubn. (inermis Harr.).—Varying in color from blackish to reddish brown; expands 2 inches. Very abundant, and very destructive.

213. velleripennis Grote.—Front wings plain black; hind wings pearly white; expands 1⅓ inches. Rare.

214. messoria Harris.—Ash-brown, with transverse wavy dark lines; expands 1¼ inches. Common.

215. annexa Treitschke.—Two light central spots upon each front wing joined by a black dash; expands 1.60 inch. Common.

216. suffusa Guenee (telifera Harris).—Front wings dark brown, with lighter broad margins; one central light spot with black dash on each side of it; expands 2 inches. Common.

217. Rilegana Morrison.—Light brown, with darker spots; expands 1 1-5 to 1 1-3 inches. Common in October.

ADITA GROTE.

218. Chionanthi Abb. and Sm.—Front wings ash, with black markings; hind wings white; expands 1⅔ inches. Rare.

MAMESTRA OCHS.

219. latex Guenee.—Front wings ashy white with a large red-centred discal spot; expands 2¼ inches. Rare; taken at Leavenworth, by Dr. Carpenter.

220. grandis Boisd.—Front wings ash brown, with two longitudinal black spots; hind wings dark brown; expands 1.95 inches. Taken at Tonganoxie, by Mr. T. B. Ashton.

221. albifusa Walker.—Ash-brown, the front wings with many small spots and wavy lines; expands 1⅓ inches. Not Common.

222. legitima Grote.—Ash, varied with reddish brown; expands 1.40 inches. Rare.

223. lorea Guenee.—Light yellowish brown varied with darker brown; expands 1.40 inches. Rare.

DIANTHOECIA BOISD.

224. capsularis Guenee.—Dark brown with clear ashy-white markings upon front wings; expands 1⅓ inches. Rare.

225. meditata Grote.—Reddish brown with irregular blue-gray lines and flecks; expands 1.30 inches. Rare.

PACHYPOLIA GROTE.

226. atricornis Grote.—Grayish black with white spots and lines; expands 2.05 inches. Rare.

HOMOHADENA GROTE.

227. Kappa Grote.—Gray-brown, with a longitudinal black line upon each front wing; expands 1.40 inches. Rare.

HADENA SCHRANK.

228. adjuncta Boisd.—Blackish brown with bright white spots; expands 1.55 inches. Rare.

229. cariosa Guenee.—Dusky white, varied with brown and black; expands 1.60 inches. Rare; taken at Leavenworth by Dr. Carpenter.

230. modica Guenee.—Front wings bluish-gray, with dark brown irregular band across center; expands 1.15 inches. Rare.

231. turbulenta Hubn.—Front wings velvety brown, lighter on marginal half; expands 1.30 inches. Rare.

232. miselioides Guenee.—Light and dark brown with an olive tinge; expands 1.20 inches. Rare.

233. Hadena sp.—An undescribed species; front wings dark brown, on basal half, ash brown on outer half; expands .95 inch. Rare.

234. chalcedonia Hubn.—Front wings brown, with base and circular spot, at apex dusky white; expands .96 inch.

235. renigera Stephens (herbimacula Guenee).—Front wings purplish brown, with olive green spots; central spot green, with its lower edge silver white; expands 1.15 inches. Common; supposed by Riley to feed upon the roots of flowers.

PERIGEA GUENEE.

236. xanthioides Guenee.—Bright yellowish-brown, with purple-brown markings; expands 1.20 inches. Abundant.

DIPTERYGIA STEPHENS.

237. pinastri Linn.—Front wings dark brownish black, with grayish white inner margins widening at the tip; when the wings are closed the light markings resemble a two-tined fork; expands 1½ inches. Common.

HYPPA DUPONCHEL.

238. xylinoides Guenee.—Ash-gray with three longitudinal black lines near inner margin of front wings; expands 1.65 inches. Rare; taken at Leavenworth by Dr. Carpenter.

ACTINOTIA HUBNER.

239. ramosula Guenee.—Gray and brown; expands 1.43 inches. Rare.

MORRISONIA GROTE.

240. evicta Grote.—Gray-brown, with two longitudinal black lines and a reddish central spot; expands 1.35 inches. Rare.

PRODENIA GUENEE.

241. Commelinæ Abb. and Sm. The Spiderwort Moth.—Front wings purplish-gray with brownish white bands and lines; hind wings pearly white; expands 1⅝ inches. Common; feeds upon spiderwort and (according to Riley) upon all sorts of succulent plants.

NEPHELODES GUENEE.

242. violans Guenee.—Front wings rich purplish brown, with darker band across center; expands 1.70 to 1.80 inches. Common.

243. Nephelodes sp.—An undetermined form, resembling the preceding but with a double band crossing front wings; expands 1⅔ inches. Taken at Leavenworth by Dr. Carpenter.

GORTYNA HUBNER.

244. limpida Guenee (cerussata Grote).—Brown, with three clusters

of small white spots upon each front wing; expands 1½ to 1⅝ inches. Taken by Dr. Carpenter.

245. nebris Guen.—Brown, with two clusters of white spots upon each front wing; expands 1.43 inches. Rare.

246. nitela Guen. The Stalk-borer.—Brown, with a bent white line crossing front wings near outer margin; expands 1.45 inches. Common; bores into the stalks of potato, tomato, dahlia, aster and cocklebur.

247. semiaperta Morrison.—Reddish-brown, with double white spot in center of front wings; expands 1¼ inches. Common.

248. cerina Grote.—Golden yellow; one specimen, the type of the species.

ARZAMA WALKER.

249. densa (?) Walk.—Reddish-brown of different shades; expands 1⅝ inches. One specimen.

CIRROPHANUS GROTE.

250. triangulifer Grote.—Golden-yellow with brownish-yellow markings; expands 1.45 inches. Rare.

SCOLECOCAMPA GUENEE.

251. liburna Geyer (ligni Guen).—Front wings brownish-white, with dark brown spot in center; expands 1.40 inches. Not common.

ACHATODES GUENEE.

252. zeæ Harr. The Cornstalk Borer.—Dark brown, with rust-red thorax and apex of front wings; expands 1.40 inches. Not common as yet; bores in the stalks of Indian corn, and is very destructive in the New England States.

LUCANIA TREITSCHKE.

253. phragmitidicola Guen.—Gray-brown, with a longitiudinal black, white edged line upon each front wing; expands 1½ inches. Common.

254. Harvegi Grote.—Grayish-white with a broken longitudinal dark line; expands 1⅓ inches. Common.

255. unipuncta Haworth.—The Army-worm Moth. Yellowish brown; a small white spot in center of each front wing; longitudinal line indistinct; expands 1¾ inches. Abundant, especially in wet seasons following very dry seasons; probably the most destructive species among all the Lepidoptera, often attacking and destroying entire fields of corn, wheat, oats, grass and other staple crops.

UFEUS GROTE.

256. satyricus Grote.—Uniform dull brown; expands 1¾ inches. Rare.

LAPHYGMA GUENEE.

257. frugiperda Abb. and Sm. (Prodenia autumnalis Riley).—The Fall Army worm. Resembles the Spiderwort Moth (No. 241), but its markings are much less distinct. Common; destroys corn, wheat, tomatoes and many other plants; bred by W. Osburn from the bracted bindweed (calystegia) and from false gromwell (Onosmodium).

PYROPHILA HUBNER.

258. pyramidoides Guenee.—Brown front wings; rust-red hind wings; expands 1.80 inches. Very common; feeds upon the grape, raspberry, poplar, and red-bud.

ORTHODES GUENEE.

259. infirma Guen.—Dark brown, interlaced with many narrow whitish lines; expands 1.40 inches. Rare.

ALETIA HUBNER.

260. argillacea Hubn. (Anomis xylina Say).—The Cotton-worm Moth. Front wings light purplish brown, with blackish spot in center; expands 1½ inches. The greatest enemy of the cotton-plant. Taken at Tonganoxie by T. B. Ashton.

ATETHMIA HUBNER.

261. pampina Guen.—Light reddish-brown, with two dark spots near center of each front wing; expands 1.60 inches. Taken by T. B. Ashton at Tonganoxie.

ORTHOSIA OCHS.

262. viatica Grote.—Dark vinous brown; expands 2.10 inches. Rare.

263. helva Grote.—Light brownish-yellow with small blackish spots; expands 1⅓ inches. Rare.

XANTHIA HUBNER.

264. ferrugineoides Guen.—Similar to the last species; expands 1.40 inches. Common.

GLÆA HUBNER.

265. anchocelioides Guenee.—Reddish-brown with two dark spots at the center and one at the apex of front wings; expands 1⅓ inches. Rare.

SCOLIOPTERYX GERMAR.

266. libatrix Guen.—Front wings brown with jagged outer edges; bright red spots in the basal portion and a transverse white line between center and outer margin; expands 1.80 inches. Not common.

LITHOPHANE HUBNER.

267. petulca Grote.—Front wings narrow and smoky-brown with many short darker lines; expands 1.70 inches. Not Common.

268. Bethunei G. and R.—Light ash-gray with brown markings; expands 1½ inches. Rare.

269. cinerea Riley.—Dark ash-gray; expands 1¾ inches. Common; feeds upon the leaves of apple, poplar, hickory, and other trees, sometimes boring into the fruit. (Riley's 3d Report.)

CUCULLIA SCHRANK.

270. asteroides Guen.—Front wings cinereous, bordered with brown; expands 2 inches. Rare.

CRAMBODES GUENEE.

271. talidiformis Guen.—Front wings brownish-white with darker markings and white discal spot; expands 1¼ inches. Abundant.

ADIPSOPHANES GROTE.

272. miscellus Grote.—Ashy-white with many fine black streaks; expands 1.10 inches. Common; bred by W. Osburn from the hoary vervain (Verbena stricta).

NOLAPHANA GROTE.

273. malana Fitch.—Ash-gray with darker lines; expands 1 inch. Not common.

274. Zelleri Grote.—Like the preceding in color and size. Common.

MARASMALUS GROTE.

275. histrio Grote.—Dark brown; expands 1 to 1.10 inches. Common.

BASILODES GUENEE.

276. pepita Guenee.—Satin-yellow, with brown circles and lines; expands 1.70 inches. Quite common.

PLUSIODONTA GUENEE.

277. compressipalpis Guen.—Yellowish, with a brown, tapering band crossing each front wing obliquely, and forming a projecting tooth on inner margin; expands 1⅛ inches. Common.

TELESILLA HERR.-SCH.

278. cinereola Guen.—Front wings grayish-brown, crossed near outer margin by a yellowish band; expands 1.10 inches. Common.

PLUSIA FABRICIUS.

The members of this genus have a bright silver spot at center of each front wing.

279. bilòba Stephens.—Brown with a large two lobed silver spot; expands 1.60 inches. Common.

280. precationis Guen.—Darker brown; expands 1.50 inches. Rare; bred from the common thistle by Riley.

281. simplex Guen.—Dark reddish-brown, with ashy edges at all the wings; expands 1½ inches. Abundant.

282. gamma Linn.—Ash-brown; expands 1.72 inches. Rare.

283. brassicæ Riley. The Cabbage Moth.—Brown, with minute ashy markings; silver spot double. Abundant; feeds upon the cabbage, gnawing large holes in the leaves.

STIRIA GROTE.

284. rugifrons Grote.—Front wings bright-yellow, with outer margin, a spot at base, and one at center of inner margin purplish-brown; hind wings white with smoky margin; expands 1.60 to 1.85 inches. Not common.

STIBADIUM GROTE.

285. spumosum Grote.—Brown, frosted with gray scales, a bent line near outer margin, much resembling Gortyna nitela; expands 1.28 to 1.66 inches. Abundant.

PLAGIOMINICUS GROTE.

286. pityochromus Grote.—Grayish-brown near center and another near apex of each front wing; expands 1.18 to 1.35 inches. Common.

SCHINIA HUBNER.

287. rectifascia Grote.—Pale yellowish brown, with three or four whitish lines crossing each front wing; expands 1.08 inches. Rare.

CHLORIDEA WESTWOOD

288. rhexiæ Abb. and Sm.—Front wings pale-green, crossed by three whitish lines; hind wings white. Not common.

ORIA GUENEE.

289. sanguinea Geyer.—Front wings purple-red, with brown band across the center; expands 1.20 inches. Rare; taken at Leavenworth by Dr. W. B. Carpenter.

ALARIA WESTWOOD.

290. gauræ Abb. and Sm. Deep pink, varied with pure white; expands 1 to 1¼ inches. Common in localities; feeds upon the wild Gaura.

LYGRANTHOECIA G. AND R.

291. marginata Haworth.—Front wings ash-brown, darker at base and along margin, crossed by three curved white lines; expands 1⅛ inches. Not common.

292. Thoreaui G. and R.—Front wings olive-brown, crossed by a broad lighter band constricted centrally; expands 1⅓ inches. Not common.

293. bimocula Grote.—Rare.

294. brevis Grote.—Front wings rich brown, with yellowish lines and small spots; hind wings black, with yellow central and basal spots; expands 1.15 inches. Rare; taken at Topeka by E. A. Popenoe, at Leavenworth by Dr. Carpenter, and at Tonganoxie by T. B. Ashton.

295. arcifera.—Dark brown, with a lighter constricted band across front wings; expands .90 inch. Not common.

296. Spraguei Grote.—Front wings like preceding, but lighter; hind wings with basal half yellow; expands 1 inch. Common.

297. lynx Guenee.—Similar to preceding, but lighter and with a blackish spot in the yellow of hind wings. Common.

298. Lygranthœcia sp.—An undetermined species; yellowish brown, with the usual lighter band upon front wings; expands 1.15 inches. Rare.

EULEUCYPTERA GROTE.

299. cumatilis Grote.—Satin-white, with basal and terminal bands of greenish upon front wings; expands 1 inch. Rare.

TRICOPIS GROTE.

300. chrysellus Grote.—Satin-white, with a basal, a central and a terminal yellowish brown band upon each front wing; expands .90 to 1 inch. Not common.

TAMILA GUENEE.

301. nundina Drury.—White, with irregular greenish bands and a double black spot upon each front wing; expands 1⅛ inches. Rare.

ÆDOPHRON LEDERER.

302. Snowi Grote.—Creamy white, tinged with pink. Rare; a single specimen taken by G. F. Gaumer in 1872.

HELIOTHIS HUBNER.

303. phlogiphagus G. and R.—Front wings dull yellowish-brown, with a central black spot; hind wings pale yellowish, with a large black central spot, and broad black margin enclosing yellowish spot; expands 1.40 inches. Not common; feeds upon phlox.

304. armigera Hubn.—The Cotton or Boll-worm Moth. Front wings brownish yellow, with a small dark central spot; hind wings dingy with blackish margin enclosing a light spot; expands 1.70 inches. Common; feeds upon unripe corn in the ear, often causing great destruction, and upon the cotton-ball in the cotton States; also attacks the green fruit of the tomato. (Riley.)

Var. umbrosus has greenish-yellow instead of brownish-yellow front wings.

HELIOCHILUS GROTE.

305. paradoxus Grote.—Front wings light greenish brown, with a pale drab discal spot; hind wings much as in the preceding; expands 1⅓ inches. Rare.

PYRRHIA HUBNER.

306. exprimens Walker.—Yellowish-brown, with rosy tinges; expands 1½ inches. Rare. Bred by W. Osburn, from the black-walnut.

TARACHE HUBNER.

307. aprica Hubn.—White with broad brown terminal margin and one or two brown spots upon front margin of front wing; expands 1 inch. Common.

Var. biplaga Guenee, has the brown more extended.

308. erastrioides Guen.—Front wings white with lower portion of terminal half brown; hind wings dusky; expands ¾ inch. Not common.

309. candefacta Hubn.—Front wings about equally white and olive brown; terminal half of hind wings dusky; expands .80 inch. Common.

Var. debilis has the white more extended.

GALGULA GUENEE.

310. hepara Guen.—Front wings dark purplish-brown, darker on basal half; hind wings plain brown; expands 1 inch. Rare.

311. subpartita Guen.—Light reddish-brown to ash-brown, with dark spot at centre of front margin; expands 1 inch. Common.

XANTHOPTERA GUENEE.

312. nigrofimbria Guen.—Front wings pale yellow with brown fringes and two brown dots near the center; expands .95 inch. Rare.

EUSTROTIA HUBNER.

313. carneola Guen.—Front wings dark brown with broad lighter terminal margin, the dark portion crossed by an oblique flesh-colored band; expands .85 inch. Abundant.

314. musta G. and R.—Light and dark brown with greenish tinge; expands ¾ inch. Common.

CHAMYRIS GUENEE.

315. cerinthia Tr.—Brownish-black with blue tinges and with white bands and lines; expands 1.20 inches. Rare.

EROTYLA HUBNER.

316. leo Guenee.—Front wings black, white, and orange; hind wings black; expands .70 inch. Rare.

METOPONIA DUPONCHEL.

317. obtusa H.-S.—Front wings yellow with brown spots; expands .92 inch. Common.

DRASTERIA HUBNER.

318. erichtea Cramer.—Brown with darker spots and bands; female more uniform in color; expands 1¾ to 2 inches. Abundant. Feeds upon clover.

Var. agricola is quite common.

EUCLIDEA HUBNER.

319. cuspidea Hubn.—Dark brown with lighter edges and nearly black, angular spots upon front wings; expands 1.40 to 1.65 inches. Common.

PARALLELIA HUBNER.

320. bistriaria Hubn.—Brown, the front wings crossed by two parallel lines; expands 1½ to 1⅔ inches. Common.

AGNOMONIA HUBNER.

321. anilis Drury (sesquistriaria Hubn.)—Front wings dark velvety-brown with one and a half white traverse lines; hind wings plain brown; expands 1.40 inches. Common.

CELIPTERA GUENEE.

322. frustulum Guenee.—Front wings ashy-brown with wavy lines; near the outer edges runs a very distinct dark brown line, edged within by a lighter line and followed by a row of black dots on the inner margin near the base; expands 1⅔ inches. Rare.

BOLINA DUPONCHEL.

323. Bolina sp.—An undetermined species is in the collection of E. A. Popenoe at Topeka.

PARTHENOS HUBNER.

324. nubilis Hubn.—Front wings brown with whitish shades; hind wings black with irregular yellow bands and spots, much resembling the next genus. Rare; a single specimen taken at Leavenworth by Dr. Carpenter.

CATOCALA SCHRANK.

The members of this large and beautiful genus have been unusually abundant during the past season (June to September, 1875), the number of species known to occur in Kansas having been increased from fifteen to forty. All but five of these have been taken at Lawrence, chiefly by Mr. Gaumer and the writer. Thirty species have been taken at Tonganoxie by Mr. T. B. Ashton, and nearly an equal number at Leavenworth, by Dr. Carpenter. As no brief description would enable one to distinguish these closely-allied forms, the forty species are divided into four well-marked groups, based upon the colors of the hind wings. The front wings are always of some shade or shades of ash or brown, often varied with black—colors admirably adapted to conceal the moths when in their usual resting places upon the trunks of trees.

FIRST GROUP: Hind wings black and unbanded.

325. Epione Drury.—Expands 2½ inches. Abundant.

326. lachrymosa Guenee.—Expands 3 inches. One specimen by Mr. Gaumer.

327. Robinsoni Grote.—Expands 2.90 inches. Not common.

328. Levettei Grote (Judith Strecker).—Expands 2.10 inches. Rare; taken at Tonganoxie by Mr. Ashton, and at Leavenworth by Dr. Carpenter.

329. insolabilis Guenee.—Hind wings with black fringes; expands 2.90 inches. Common.

330. simulatilis Grote.—Expands 2.90 inches. One specimen taken by Mr. Gaumer.

331. obscura Strecker.—Expands 2.45 to 2.90 inches. Taken by Mr. Ashton. Much resembling the preceding species, but the t. p. and the t. a. lines are separated on the inner margin of the front wings only 0.08 inch, while in simulatilis they are separated 0.23 inch.

332. viduata Guenee.—Expands 3½ inches. Rare; taken by Mr. Gaumer, in the tops of high elm trees.

333. desperata Guenee.—Expands 3.10 to 3.50 inches. Common.

334. retecta Grote.—Expands 2¾ inches. Not common.

335. flebilis Grote.—Expands 2.80 inches. Rare; taken by Mr. Ashton and Dr. Carpenter.

SECOND GROUP: Hind wings red with two black bands (a central and a terminal).

336. Walshii Edwards.—Expands 3.20 to 3.40 inches. Not rare.

337. parta Guenee.—Expands 3½ inches. One specimen, taken by Miss A. E. Mozley; feeds upon willow.

338. coccinata Grote.—Expands 2⅔ inches. Taken by Dr. Carpenter and Mr. Ashton.

339. ultronia Hubner.—Expands 2 to 2⅓ inches. Common.

340. amatrix Hubner.—Expands 3.40 inches. Common.

341. cara Guenee.—Expands 3⅓ inches. Not common.

342. Ilia Cramer.—Expands 3.15 to 3.50 inches. Common.

343. Snowiana Grote Mss.—Allied to Ilia; one specimen only.

THIRD GROUP: Hind wings yellow, with the two black bands.

344. innubens Guenee.—Expands 2½ to 2¾ inches. Abundant.

Var. scintillans Grote, is quite common.

345. adoptiva Grote (Delilah Strecker).—Expands 2.40 to 2.55 inches. Rare.

346. neogama Guenee.—Expands 3 to 3¼ inches. Abundant.

347. subnata Grote.—Expands 3.45 to 3.60 inches. Common, especially at Tonganoxie.

348. piatrix Grote.—Expands 3 to 3⅓ inches. Abundant.

349. palæogama Guenee.—Expands 2.60 to 2.90 inches. Abundant.

Var. phalanga also occurs.

350. consors Abb. and Sm.—Expands 2.40 inches. Not common.

351. nebulosa Edwards (ponderosa G. and R.).—Expands 3 to 3.45 inches. Rare.

352. serena Edwards.—Expands 2.35 inches. Rare; one specimen, taken by A. Atchison.

353. illecta Walker (Magdalena Strecker).—Expands 2.60 inches. Rare; taken at Lawrence by Miss M. E. Brett, and at Tonganoxie by Mr. Ashton.

354. nuptialis Walker (Myrrha Strecker).—Expands 2 inches. Common.

355. abbreviatella Grote.—Closely allied to the preceding, of which it is probably a variety; it is of a lighter color, and has the black reniform spot annulate with an ash-gray centre. Rare; one specimen taken by Mr. Gaumer.

356. polygama Guenee.—Expands 2 inches. Not common.

357. mira Grote Mss.—Allied to the preceding. Rare; taken by Mr. Gaumer.

358. Amasia Abb. and Sm.—Expands 1.85 inches. One specimen taken by Mr. Gaumer.

359. Catocala sp.—An undetermined species, taken at Leavenworth by Dr. Carpenter; expands 1.95 inches. One specimen only.

360. Grynea Cramer.—Expands 1⅞ inches. Quite common.

361. fratercula G. and R.—Expands 1.80 inches. Not common.

362. minuta Edwards.—Expands 1.70 inches. One specimen only.

FOURTH GROUP: Hind wings yellow without central band.

364. Belfragiana Harvey (jocasta Strecker). Expands 1.95 inches. Rare; taken by Dr. Carpenter and Mr. Gaumer. The specimens agree very well with the description of messalina Guenee.

SPILOLOMA GROTE.

365. lunilinea Grote.—Ash-brown, with four small black spots on front margin of front wings; a dark line upon the inner half of the centre of each wing; expands 1.90 to 2.25 inches. Rare.

PANOPODA GUENEE.

366. rufimargo Hubn.—Brown, the front wings crossed by a dark-brown between two reddish lines; collar and front edge of front wings red; expands 1.85 inches. Rare.

367. carneicosta Guenee.—Much like the last, but with margins of front wings flesh-colored, and with two black spots near the centre of each front wing; expands 1¾ inches. Not common.

REMIGIA GUENEE.

368. latipes Guenee.—Colored and marked much like No. 366; the hind pair of legs very broadly fringed; expands 2.05 to 2.20 inches. Not common.

HOMOPTERA BOISD.

369. lunata Drury.—Wood-brown, with darker curved lines; expands 1.90 to 2.20 inches. Abundant.

370. Saundersii Bethune.—Like the last, but with a narrow milk-white line near outer edge of each wing. Common.

371. edusa Drury.—Like the last two species in size and color; a broad milk-white band near edge of each wing. Common.

PSEUDANTHRACIA GROTE.

372. coracias Guen.—Dark brown, with black spots and lines; expands 1½ inches. One specimen only.

ZALE HUBNER.

373. horrida Hubn.—Brownish-black, with a broad light brown margin upon each wing; expands 1.55 inches. One specimen.

MATIGRAMMA.

374. pulverilinea Grote.—Ash-brown, with lighter margins; surface powdered with gray scales; expands 1¼ inches. Rare.

SPARGALOMA GROTE.

375. sexpunctata Grote.—Ash-brown, with several small black spots near apex, and a black band across center of each front wing; expands 1⅛ inches. Rare.

PHALÆNOSTOLA GROTE.

376. larentioides Grote.—Brown, with two dark bands across each wing; expands .82 inch.

PSEUDAGLOSSA GROTE.

377. lubricalis Geyer (Helia phæalis Guen).—Dark brown, with lighter shades; expands 1 inch. Common.

378. denticulatus Harvey.—Brown, with whitish spots and lines; a black spot near apex of each front wing; expands 1.30 inches. Rare.

HOMOPYRALIS GROTE.

379. tactus Grote.—Dark brown, with small light spots along front margin of front wings; expands 1 inch. Not common.

PALTHIS HUBNER.

380. angulalis Hubn.—Brown, with an irregular black band across each front wing; expands 1.10 inches. Rare.

PHALÆNOPHANA GROTE.

381. rurigena Grote.—Brownish-white, with darker shades; expands .90 inch. Rare.

BLEPTINA GUENEE.

382. caradrinalis Guen.—Pale brown, with dark spot near center of each front wing; expands 1.05 inches. Rare.

RENIA GUENEE.

383. Renia sp.—An undetermined species, similar in color to the last; expands 1.10 inches. Rare.

BOMOLOCHA HUBNER.

384. Baltimoralis Guenee.—Light and dark brown; expands 1⅓ inches. Rare.

385. bijugalis Walker.—Dark brown, with a light band across each front wing and a light spot near the apex. Rare.

HYPENA SCHRANK.

386. humuli Harris. The Hop-vine Hypena.—Front wings blackish brown, sometimes lighter, crossed by two dark lines; long feelers very conspicuous in front; expands 1.30 inches. Abundant; feeds upon the hop-vine, often being very destructive.

387. Hypena sp.—An undetermined species, taken at Leavenworth by Dr. Carpenter.

PLATYHYPENA GROTE.

388. scabra Fabr.—Much like the preceding in appearance; expands 1.40 inches. Abundant.

Family XIII.

PHALÆNIDAE. THE GEOMETRIDS.

The larvæ of this family have been called span-worms or geometers, on account of their mode of locomotion; reaching forwards they grasp the surface over which they are moving, with their front legs, and then bring up the hind legs to the same spot, forming an arch or loop with the body. The moths, when at rest, do not close the front wings over the hind wings, but allow them to remain extended. For aid in the determination of these moths, I am indebted to A. S. Packard, Jr., M. D., of Salem, Mass., who is preparing a monograph upon this difficult family. As much of my material has not yet returned, several of the species are introduced without comment.

APLODES GUENEE.

389. mimosaria (?) Guenee.—Bright green, each front wing crossed by two white lines; expands 1¼ inches. Rare.

EUCROSTIS HUBNER.

390. chloroleucaria Guen.—Pale green, with a white band crossing each wing; expands ⅔ inch. Common.

SYNCHLORA PACKARD.

391. rubivoraria Riley. The Raspberry Geometer.—Same color as the last; each wing crossed by two whitish lines. Common; feeds upon the fruit of the raspberry and blackberry; sometimes unwittingly eaten with these fruits.

SEMIOTHISA PACKARD.

392. Californiata Packard.—Rare.

393. ocellinata Guenee.—Ash-gray, with darker margins; expands 1 inch. Common; bred from the common locust (Robinia pseudacacia) by W. Osburn.

ASPILATES TREITSCHKE.

394. 4-fasciata Packard.—White, the front wings with four, the hind wings with two narrow dusky bands; expands 1.17 inches. Rare.

395. pervaria Pack.—Dusky white; expands 1.28 inches. Rare.

396. dissimilaria Hubner.

CORYCIA DUPONCHEL.

397. Corycia sp.—An undetermined species; pure silky white; expands 1.10 inches.

398. hermineata Guenee.

HÆMATOPIS HUBN.

399. grataria Fabr. The Chickweed Geometer.—Yellow, with red bands upon all the wings and a red central spot upon each front wing; expands 1 to 1.05 inches. Feeds upon Chickweed. Exceedingly abundant.

PHASIANE DUPONCHEL.

400. mellistrigata Grote.—Ash-color, each wing crossed by a very distinct brown band, that upon the front wings having a yellowish edge; expands 1 inch. Common.

401. Snoviata Packard.—Rare.

LYTHRIA HUBNER.

402. Snoviana Packard.—Rare.

ANGERONA DUP.

403. crocataria Fabr. The Strawberry Geometer.—Bright yellow, with brown spots; expands 1.45 to 1.65 inches. Common; feeds on the strawberry.

ENDROPIA GUENEE.

404. hypochraria H.-Sch.—Dark brown, with broad outer margins of a lighter brown; expands 1.50 to 1.62 inches.

405. effectaria Walker.—Light brown, with broad margins of a darker brown; expands 1½ inches.

406. serrata Drury.—Light yellow, with broad brown margins; expands 1.95 inches.

407. mugaria (?) Walk.—Dingy brown, crossed by darker lines; expands 1.35 inches.

408. trilinearia Pack.

409. Endropia sp. (near aufactaria).

410. Endropia sp.—An undetermined species.

CABERODES GUENEE.

411. metrocamparia Guen.—Dusky white, each wing with brown discal spot and transverse narrow band; expands 1.70 inches.

412. confusaria Hubn.

TETRACIS GUENEE.

413. crocallata Guen.—A mutilated specimen.

NEMATOCAMPA GUENEE.

414. filamentaria Guen.—Yellowish-brown, with reddish brown lines and dots; expands ¾ inch. Feeds upon the strawberry.

CHOERODES GUENEE.

415. Chœrodes sp.—An undetermined species; yellowish brown with darker broad margins; expands 2⅛ inches. Common.

ABRAXAS LEACH.

416. ribearia Fitch. The Currant-worm Moth.—Yellowish white, with smoky markings; expands 1.30 to 1.40 inches. Common; devours the foliage of the currant and gooseberry, often stripping the bushes of every leaf.

ENNOMOS TREITS.

417. magnaria Guenee.—Yellow, with brownish margins and spots; expands 1.90 inches.

SELENIA HUBNER.

418. Selenia sp.—An undetermined species.

PRIOCYLA GUENEE.

419. bilinearia Pack.—Yellowish brown, with three black spots upon each front wing; expands 1½ inches.

420. armataria.—Light grayish brown, with transverse reddish lines upon each wing; expands 1 inch. Common; feeds upon the currant and gooseberry.

PLEMYRIA HUBNER.

421. fluviata Hubn.—Reddish brown, crossed by several whitish lines; expands .80 inch.

422. multilineata Pack.—Reddish brown, crossed by many whitish lines; expands .95 inch.

HYPERETIS GUENEE.

423. alienaria H.-Sch.

HETEROLOCHA LEDERER.

424. sulphuraria Pack.—Taken at Leavenworth, by Dr. Carpenter.

EUTRAPELA HUBNER.

425. transversata Drury.

EUPHYJA HUBNER.

426. senulata Pack.

EPIONE DUP.

427. depontanata Grote.—Yellow, with brown margins; expands 1.40 inches.

428. Epione sp.—An undetermined species, probably new.

AZELINA.

429. Hubnerarii Pack.

AMPHIDASIS TREITSCHKE.

430.—cognataria Guenee.—Gray, with blackish lines and minute spots; very stout body; expands 2¼ inches. Feeds upon the gooseberry, Missouri currant, and Spiræa (Packard).

CYMATOPHORA TREITS.

431. ambrosaria Hubn.

432. pampinaria Guenee.—Gray, crossed by three black lines upon front wings, only one or two lines upon hind wings; expands 1.45 inches.

BRONCHELIA GUENEE.

433. hortaria Guenee.—Grayish white, crossed by several blackish wavy lines; expands 2.10 inches.

PARAPHIA GUENEE.

434. deplanaria Guenee.

CODONIA HÜBNER.

435. pendulinaria Guenee.

ACIDALIA TREITS.

436. purata Guenee.

437. 5-lineata Pack.

MACARIA CURTIS.

438. subminiata Pack.—Grayish, with vermillion suffusion; expands 1 inch.

PSAMMATODES GUENEE.

439. eremiata Guenee.

CIDARIA TREITS.

440. diversilineata Hubn.—Yellow, varied with brown; expands 1.40 inches.

EUPITHECIA CURTIS.

441. Eupethecia sp.—An undetermined species.

Family XIV.

PYRALIDÆ: SNOUT-MOTHS, OR DELTOIDS.

So called from their slender, elongated feelers or palpi, extending directly forward from the head.

PYRALIS SCHRANK.

442. farinalis Harr. The Meal Moth.—Reddish-brown at base and tip of front wings; elsewhere grayish-brown, crossed by white lines; expands 0.95 inch. Common; found in old flour boxes and in barns.

PANTOGRAPHA LEDERER.

443. limata G. and R.—Yellowish-white, semi-transparent, with a large brown area upon the lower two-thirds of outer margin of each front wing; brown lines and circles upon the yellowish portions; expands 1.40 inches. Not common. Taken at Leavenworth by Dr. Carpenter.

PHACELLURA GUILDING.

444. hyalinatalis Linn. Cucumber Moth.—Pearly, semi-transparent white, with regular, broad brown margins. Common; damages cucumbers by boring into them.

445. nitidalis.—Taken at Manhattan by H. A. Brous. Has the same habits as 444.

ASOPIA TREITSCHKE.

446. olinalis Guenee.—Purplish brown, with yellowish markings; expands 1 inch. Common.

447. squamealis Grote.—Purplish-brown; expands 0.90 inch. Rare.

HYDROCAMPA GUENEE.

448. germinalis Lederer.—White, with black and yellow markings; expands 0.75 to 0.85 inch. Taken over water surfaces, the larvæ being aquatic in their habits.

BOTYS LATREILLE.

449. flavidalis Guenee.—Pale yellow, with about four wavy brown lines crossing all the wings; expands 1.10 to 1.40 inches. Common.

450. plectilis G. and R.—Grayish brown, with whitish spots; expands ¾ inch. Common.

451. penitalis Grote Mss. The Lily Moth.—Yellowish brown, with wavy lines of a darker shade; expands 1.20 inches. Common; feeds upon the "receptacle" of the Western water-lily (Nelumbium luteum); also bred from dogs-bane (Apocynum cannabinum).

452. argyralis Hubn.—Light yellowish brown, with whitish spots; expands 1 inch. Common.

453. ventralis G. and R.—Smoky brown, with whitish spots; expands 1 inch. Not common.

454. generosa G. and R.—Dark brown, with yellow spots; expands ⅔ inch. Not common.

455. sexmaculalis Grote Mss.—Yellowish-white, with from 6 to 8 bright brown black-edged spots upon each front wing; expands .75 to .85 inch. Rare.

456. diffissa G. and R.—Front wings purple, with a yellow band; hind wings brick-red; expands .70 inch. Rare.

457. Botys sp.—An undetermined species, varying from yellowish-brown to smoky-brown; expands ⅞ inch. Abundant.

458. Botys sp.—Yellow, with brown and purplish markings; expands .80 inch. Common; bred by W. Osburn from the wild sage (Salvia).

459. Botys sp.—Yellow and purple; expands .60 inch. Rare.

DESMIA WESTWOOD.

460. maculalis Westw. The Grape-vine Leaf-folder.—Black, with white spots; two upon each front wing and one upon each hind wing; expands .95 to 1.20 inches. Common; feeds upon the grape-vine, the leaves of which it folds together.

NOMOPHILA HUBNER.

461. noctuella W. V.—Brown of different shades; expands 1¼ inches. Abundant.

PEMPELIA HUBNER.

462. Pempelia sp.—White with blackish markings; expands 1 inch. Rare.

463. Pempelia sp.—Ashy brown; expands .95 inch. Rare.

CRAMBUS FAB.

464. exsiccatus Zeller.—Grayish with darker markings; expands 1 inch. Common.

465. Crambus sp.—Grayish-white; expands 1 inch.

CRYPTOLECHIA ZELLER.

466. Schlægeri Zeller.—White with gray markings; expands .85 to 1 inch. Rare.

GALLERIA ZELLER.

467. cereana Fabr. Bee-Moth.—Dusky-gray with brown markings; expands 1¼ inches. Common; very destructive to the "comb" in bee-hives.

ARGYRIA HUBNER.

468. chamæchryulla Walker.—Satin-white, with very narrow brown outer edge upon front wings; expands .80 to .95 inch. Common.

CONCHYLODES GUENEE.

469. platinalis Guen.—Semi-transparent white, with black ring in centre of each front wing and black lines upon all the wings; expands 1.08 inches. Rare.

SCHOENOBIUS DUPONCHEL.

470. longirostrellus.—Yellow, with a narrow brown oblique band from apex of each front wing; expands .92 inch. Rare.

CONDYLOPEZA ZELLER.

471. nigrinodis Zeller.—Reddish-brown; expands .70 inch. Rare.

LIPOCOSMA LEDERER.

472. nivalis Walker.—Dull white, with centre of hind wings black; expands .60 inch. Rare.

OMPHALOCERA LEDERER.

473. cariosa Lederer.—Dull brown, with darker spot upon each front wing; expands 1¼ inches. Rare.

Family XV.

TORTRICIDÆ. LEAF-ROLLERS.

TORTRIX TREITSCHKE.

474. sulphureana Clemens.—Sulphur-yellow, with red spots; expands .80 inch. Common.

475. Rileyana Grote.—Ochre-yellow, with small square brown spots upon front wings; expands .85 inch. Common; feeds upon buckeye (bred from it by Mr. Gaumer), walnut, hickory, and snowberry. (Riley.)

476, 477, and 478. Tortrix sp.—Three undetermined species.

LOXOTÆNIA STEPHENS.

479. rosaceana Harris.—Yellowish brown, with darker bands; expands 1.15 inches. Common; destroys the tender leaves of the apple.

CARPOCAPSA TREITSCH.

480. pomonella Linn. The Codling Moth.—Brown, crossed by many gray and brown lines; a large dark brown spot with copper edge on lower half of tip of front wings. Common; is the cause of "wormy apples," the larva burrowing into the fruit from the "blossom end," and generally causing it to fall to the ground before ripening.

PENTHINA TREITSCH.

481. vitivorana Pack. The Grape Codling.—Light bluish, with a brown band and one or two brown spots upon each front wing; expands 0.40 inch. Not common; feeds upon the pulp of the grape.

GRAPHOLITHA LEDERER.

482. Grapholitha sp.—An undetermined species; brown, with a yellowish white spot on lower half of the outer margin of front wings; expands 0.80 inch. Common.

POECILOCHROMA CLEMENS.

483. dorsisignatum Clemens.—Ash color, with black spot at centre of inner margin of each front wing; expands 0.85 to 0.95 inch.

CONCHYLIS TREITS.

484. 5-maculana Robinson.—Brown, with five white spots upon each front wing; expands ⅔ inch. Rare.

Family XVI.

TINEIDÆ. THE TINEIDS.

The members of this family have the wings long and narrow, with long

fringes; from their diminutive size they have been called "micro-lepidoptera."

TINEA FABRICIUS.

485. flavifrontella Linn. The Clothes Moth.—Yellowish white; expands ½ inch. Common; very destructive to woolens and furs.

OETA GROTE.

486. compta Clemens. The Ailanthus Moth.—Front wings bright orange yellow, with transverse rows of pale yellowish spots; hind wings dusky; expands 0.85 inch. Rare; feeds upon the ailanthus tree.

HYPONOMEUTA ZELLER.

487. multipunctella Clemens. The Wahoo Moth.—Snowy white with longitudinal rows of black dots upon the front wings; female with hind wings blackish gray, and basal portion of anterior edge of front wings black; expands 0.90 inch. Not common. Bred from the wahoo (Euonymus atropurpureus), by G. F. Gaumer, who has described this insect in all its stages.

PRONUBA RILEY.

488. yuccasella Riley. The Yucca Moth.—Front wings pure white; hind wings grayish brown; expands 0.95 to 1.10 of an inch. Taken in Western Kansas, by H. A. Brous; feeds upon the wild species of Yucca, being essential to the "fertilization" of that genus of plants, as discovered by Mr. Riley.

Family XVII.

PTEROPHORIDÆ. PLUME MOTHS.

PTEROPHORUS GEOFFR.

The members of this genus have the front wings cleft, and the hind wings parted into three divisions.

489. periscelidactylus Fitch. The Grape Plume.—Yellowish brown, with spots of white and dark brown; expands .60 inch. Not common; feeds upon the young leaves of the grape vine, which it fastens together with silky threads.

ADDENDA.

Since the foregoing went to press, the following additions have been made:

ORGYIA OCHS. (Bombycidæ, four species.)

490. leucostigma Sm. The white-marked Tussock-moth.—Not common.

DATANA WALKER.

491. ministra Drury. The Handmaid Moth.—Common and destructive.

PTILODONTES.

492. Ptilodontes n. sp.—One specimen, taken by Mr. Gaumer.

ARCTIA SCHK.

493. Snowi Grote.—Described in Can. Entomologist for Oct., 1875.

JASPIDEA HUBNER. (Noctuidæ, eight species.)

494. Jaspidea sp.—An undetermined species.

AGROTIS HUBN.

495. venerabilis Walk.—Not common.

DORYODES WALKER.

496. acutaria H.-Sch.—Grayish white, with a broad, brownish, longitudinal band upon each front wing; expands 1½ inches.

CARADRINA OCHS.

497. grata Hubn.—Reddish-brown, each front wing crossed by two whitish lines; expands .90 to 1.05 inches. Common.

PLUSIA FABR.

498. pedalis Grote.—Described in Can. Ent. for Nov., 1875.

HELIOTHIS HUBNER.

499. luteitinctus Grote.—Allied to phlogriphagus.

BOLINA DUP.

500. jucunda Hubn.—One specimen, taken by Wm. Osburn.

EREBUS LATREILLE.

501. odora Linn.—Taken at Manhattan, by H. A. Brous; expands 6 inches.

ANISOPTERYX STEPH. (Phalænidæ.)

502. vernata Peck. The Spring Canker-worm Moth.—Rare.

LIPOCOSMA LEDERER. (Pyralidæ.)

503. albolineata G. & R.—Rare.

Summary of Species.

Diurnal Lepidoptera, or Butterflies	77
Sphingidæ, or Hawk Moths	27
Ægeriadæ or Ægerians	4
Zygænidæ	4
Bombycidæ, or Silkworm Moths	75
Noctuidæ, or Owlet Moths	213
Phalænidæ, or Geometrids	54
Pyralidæ, or Snout Moths	33
Tortricidæ, or Leaf-rollers	11
Tineidæ, or Tineids	4
Pterophoridæ, or Plume Moths	1
Total number of species catalogued	503

METEOROLOGICAL SUMMARY FOR 1875

PROF. F. H. SNOW'S ANNUAL REPORT AS METEOROLOGIST TO THE STATE BOARD OF AGRICULTURE.

Station: Lawrence, Kansas; latitude 38° 58′; longitude 95° 16′; elevation of barometer and thermometers, 884 feet above the sea level, and 14 feet above the ground; rain gauge on the ground; anemometer 105

feet above the ground, on the dome of the University building, 1,150 feet above the sea level.

The following features of the weather of 1875 deserve special notice:

1. The very low mean temperatures of January and February and the generally low mean temperatures of the remaining months of the year, except December, which was remarkably warm, being more than 12° warmer than the December average, and nearly 4° warmer than November.

2. The large deficiency in the rainfall for the months of August, September, October and November. The rains during the preceding months had been abundant, though not excessive, so that the subsequent deficiency did not in the least interfere with the proper growth and maturity of immense crops throughout the State. We have here an excellent illustration of the principle, to which attention was called in my report for the year 1871, that a comparatively small amount of rain well distributed is much better than a large amount unfavorably distributed.

3. The extremely small amount of snow is a marked meterological peculiarity of the year.

4. We have a splendid example of the great advantage possessed by the State of Kansas in the long period of absence of severe frosts, so that a disaster occurring to the crops in the early part of the summer, may be fully retrieved by a second, third, or even a fourth planting. On the 15th of June, a large portion of Eastern Kansas had been shorn of vegetation, by the plague of the locusts. Yet corn planted from that date up to the 10th of July, in the desolated districts, yielded bountiful crops, the first severe frost of autumn occurring on the 30th of October, too late to damage the well-ripened ears.

The following is a summary of the weather for the year:

TEMPERATURE.

Mean temperature of the year, 50°.60, which is 2°.53 below the mean of the seven preceding years. The highest temperature was 99°, on the 22d of June. The lowest temperature was 16°.5 below zero, on the 9th of January. Mean temperature at 7 a. m., 44°.2; at 2 p. m., 60°.2; at 9 p. m., 48°.8.

Mean temperature of the winter months, 25.°62—3°.19 below the aveage; of the spring, 50°.60—2°.70 below the average; of the summer, 74°.87—2°.17 below the average; of the autumn, 51°.49—1°.04 below the average.

The coldest month of the year was January—the coldest January, and the coldest month on our record—with mean temperature 15°.60; the coldest week was January 8th-14th, with mean temperature 1°.94; the coldest days were January 13th and 14th, with mean temperatures 7°.7 below zero. The mercury fell below zero 12 times, 9 of which were in January and 3 in February.

The hottest month of the year was July, with mean temperature of 76°.63; the hottest week was June 19th to 25th, mean temperature 83°.41; the hottest days were June 22d and July 16, which each had a mean temperature of 86°.6. The mercury reached or exceeded 90° on 32 days, viz: 3 in May, 13 in June, 8 in July, 2 in August, and 6 in September. There were 58 such days in 1874. The mercury did not reach 100° during the year.

The last light frost of spring was on May 4th; The first light frost of autumn was on September 18th, giving a period of 137 days entirely without frost. The last severe frost of spring was on April 17th; the first

severe frost of autumn was on October 30th, giving a period of 196 days without severe frost. No cold weather during the year caused any damage to fruit.

RAIN.

The entire amount of rain, including melted snow, was 28.87 inches, which is precisely the same amount as in 1874, and falls below the average rainfall of the past eight years by 4.11 inches. Either rain or snow fell on 106 days, 4 more than the average number. The longest interval without rain, during the growing season, March 1st to October 1st, was 18 days, June 8th to 27th. The number of thunder showers was 21.

SNOW.

The entire depth of snow was 5 inches, which is the least annual amount on our eight years' record, and is 20.36 inches below the average. Of this amount 4 inches fell in February and 1 inch in March. There were flurries of snow in January, April, November and December. The last snow flurry of spring was on April 12th; the first snow of autumn was on November 13th.

FACE OF THE SKY.

Average cloudiness of the year 44.81 per cent. of the sky, which is only .78 per cent. below the average. The number of clear days (less than one-third cloudy) was 162; half clear days (between one-third and two-thirds cloudy), 115; cloudy (more than two-thirds), 88. There were 23 days without a cloud, and an equal number without a trace of sky. June was the clearest month, with a mean cloudiness of 31.44 per cent. January was the cloudiest month, mean cloudiness 54.84 per cent. The mean cloudiness at 7 a. m., was 47.67 per cent.; at 2 p. m., 48.32 per cent.; at 9 p. m., 38.44 per cent.

DIRECTION OF THE WIND.

During the year (three observations daily) the wind was from the southwest, 330 times; northwest, 298 times; southeast, 161 times; northeast, 135 times; south, 61 times; east, 47 times; north, 38 times; west, 10 times; calm, 15 times. The south (including southeast, south and southwest) winds outnumbered the north (including northeast, north and northwest) winds in the ratio of 552 to 471.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 145,316. This gives a mean daily velocity of 398.12 miles, and a mean hourly velocity of 16.59 miles. The position of the anemometer cups at an elevation of 105 feet above the top of Mt. Oread, 325 feet above the river level, secures exposure to the full force of the wind. The maximum velocity was 75 miles an hour, on January 8th. The greatest daily velocity was 1,070 miles, on February 3d. The strongest winds were in March and April; the lightest were in July and August.

BAROMETER.

Mean height of the barometer column, 29.102 inches. Mean, at 7 a. m., 29.126 inches; at 2 p. m., 29.077 inches; at 9 p. m., 29.103 inches; maximum, 29.856 inches, at 7 a. m., January 9th; minimum, 28.344 inches, at 2 p. m., May 7th, giving a yearly range of 1.512 inches. The highest monthly mean was in January, 29.303 inches; the lowest was in May, 29.006 inches. The

barometer observations are corrected for temperature, but not for elevation, thus affording the means of determining the altitude of our station.

RELATIVE HUMIDITY.

Mean for the year, 65.53; at 7 a. m., 77.35; at 2 p. m., 46.58; at 9 p. m., 72.68. The dampest month was January; humidity, 78.10. The driest month was April; humidity, 57.60. There were only five fogs during the year. The minimum humidity for any single observation was 9 per cent. of saturation, at 2 p. m., March 27th.

The following table gives the mean temperature, the extremes of temperature, the relative humidity and the rainfall for each month of the year 1875, and a comparison with preceding years:

Month	Mean Temperature	Maximum Temperature	Minimum Temperature	Relative Humidity	Rainfall in Inches	Excess or Deficiency of Rainfall
January	15.60	46.0	—16.5	78.10	0.12	1.34 def.
February	21.92	55.0	— 8.0	74.72	0.80	0.16 def.
March	37.10	82.0	9.5	64.93	2.61	0.50 ex.
April	49.70	82.0	23.0	57.60	2.51	0.41 def.
May	65.00	95.0	30.0	60.30	3.39	0.31 def.
June	75.47	99.0	49.0	60.20	3.45	0.14 def.
July	76.63	97.5	65.0	73.05	6.60	2.02 ex.
August	72.50	91.0	55.0	68.08	2.90	1.51 def.
September	65.75	95.0	38.0	64.35	1.39	2.30 def.
October	53.18	86.0	25.0	56.23	1.16	1.35 def.
November	35.55	70.0	2.0	62.13	0.36	1.55 def.
December	39.35	73.0	0.0	66.66	3.55	1.88 ex.
Year 1875	50.60	90.0	—16.5	65.53	28.87	4.11 def.
" 1874	54.20	108.0	— 3.0	65.52	28.87	4.11 def.
" 1873	52.71	104.0	— 26.0	64.06	32.94	0.04 def.
" 1872	51.90	97.0	—18.0	64.40	32.63	0.35 def.
" 1871	54.30	103.0	— 6.0	.....	33.23	0.25 ex.
" 1870	54.50	102.0	—10.0	68.40	31.38	1.60 def.
" 1869	50.99	96.0	— 5.0	.....	38.51	5.53 ex.
" 1868	53.36	101.0	—16.0	.....	37.42	4.44 ex.

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TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE.

VOL. V.

1877.

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PROCEEDINGS.

The ninth annual meeting of the Kansas Academy of Science convened at Topeka on the 14th of November, 1876, and closed its session at 10 p. m. on the 15th. Previous to the more public exercises of the Academy, held in the Senate chamber of the capitol, a meeting assembled at the office of Dr. Thompson for the transaction of business. On recommendation of the committee on nominations, the officers of the past year were reelected, viz.:

President—F. H. Snow.

Vice Presidents—B. F. Mudge and J. H. Carruth.

Treasurer—R. J. Brown.

Secretary—J. Savage.

Several changes were made in the commissions of the Academy, among which are the following: E. A. Popenoe was appointed to that of Botany, Prof. Dunbar to that of Philology, Dr. Thompson to that of Meteorology, and C. K. Jones to that of Geology. A new commission was added to the former list—that of Ethnology—and J. D. Parker and B. F. Mudge were appointed to it. A new interest has attached itself to this latter branch of study, by the discovery of a large number of mounds on the bluffs opposite Kansas City, Mo.

The following articles were added to the constitution of the Academy:

ART. VI. There shall be a meeting held during the summer months for the purpose of hearing scientific lectures of a popular character.

ART. VII. These meetings shall be known as the "popular meetings" of the Kansas Academy of Science, and shall be held in such places as may be selected at the annual meeting.

ART. VIII. Every member is expected to present some fact for the benefit of science, to be kept as a record, and to appear in the regular proceedings.

Resolved, That Leavenworth be selected as the place for the first popular meeting, to be held in June, 1877, and that H. M. Aller, W. S. Burke and James Wilson be appointed as committee on local arrangements.

Resolved, That Professors Mudge, Kedzie and Snow be appointed lecturers for that meeting.

It was further

Resolved, That a committee of three be appointed to take into consideration the need of additional room for the accommodation of the cabinet of the Society, with power to confer with the Kansas Historical Society, Topeka, and the State Board of Agriculture.

B. F. Mudge, Dr. Thompson and E. A. Popenoe were chosen upon this committee.

A resolution recommending a geological survey of the State was presented, and carried with much favor by the Academy. The products of our coal mines have already taken a position in the material prosperity of our State almost beyond computation: a careful survey of these formations would tend to fix more definitely the boundary line between our fertile coal measures and those that are barren.

Prof. C. V. Riley, of St. Louis, gave the opening lecture of the session, upon "The Locust Problem."

Prof. F. W. Bardwell, of the State University, gave the lecture of the second evening, upon "Our Neighbor the Moon."

The following papers were read before the Academy, and, as far as space will allow, are given entire:

1. On the Occurrence of the Mastodon in the Pliocene of Kansas: B. F. Mudge, Manhattan.
2. Climate vs. Brains: Prof. M. V. B. Knox, Baker University.
3. On the Recent Additions to the Flora of Kansas: Prof. J. H. Carruth, Lawrence.
4. On the Coleoptera of Kansas: Edwin A. Popenoe, Topeka.
5. On Colorado Coleoptera: Prof. F. H. Snow, State University.
6. On the Mineral Water at Iola, Kansas: Prof. Geo. E. Patrick, State University.
7. On the Habits of Amblychila Cylindriformis: H. A. Brous, Manhattan.
8. On Additions to the Catalogue of Kansas Mammals: Prof. M. V. B. Knox.
9. On a Meteorite found in Mitchell County, Kansas: Prof. Geo. E. Patrick.
10. On Arithmetical Methods: Prof. F. W. Bardwell, State University.
11. On the Prairie Dog in Kansas: H. A. Brous.
12. On the Appearance of an Egg-Parasite of the Rocky Mountain Locust: Prof. F. H. Snow.
13. On the Influence of Food-Selection upon the Evolution of Animal Life: A. H. Thompson, M. D., Topeka.

JOSEPH SAVAGE,
Secretary Kansas Academy of Science.

ANNUAL REPORT OF THE COMMITTEE ON GEOLOGY, FOR THE YEAR ENDING NOVEMBER 1, 1876.

By Prof. B. F. Mudge.

During the past year many important additions have been made to the cabinet of this department. Our cases were already filled at the beginning of the year; consequently, the new collections could not be classified and arranged as they otherwise would have been.

Many persons not members of the Academy have made donations to the cabinet, to whom the thanks of this Society are due. In some instances the names of the donors are unknown. It is desirable that the contributor's name should accompany the specimens when sent.

Your chairman has added a full suite of minerals from the lead and zinc workings in the southeastern portion of this State, and four large boxes from the cretaceous of western Kansas. These are yet unopened, for want of room on our shelves. He has the past year, as previously, been engaged the greater part of the time, with four scientific assistants, in exploring the Niobrara group of the cretaceous of Kansas, beyond the settlements, and collecting the fossil vertebrates of those deposits. This party being in the pay and interest of Yale College, all the most valuable specimens were sent to that institution. But while Yale added to its museum, we at the same time added to our knowledge of geology much that is important and valuable to us as a State. Information has thus been acquired during the past three years which will enable us to map correctly the outlines of the Cretaceous and Tertiary formations, and to substantiate scientific facts peculiar to the fossils of those ages.

Thus we have found a rare form of crinoid, which has been described in the American Journal of Science, vol. XII, p. 81, by G. B. Grennell, as Uintacrinus socialis. This was also found in Utah by Prof. Marsh's party. It is the more worthy of note, as until quite recently, neither in Europe nor America had crinoids been discovered in the Cretaceous. We have learned, too, of the pterodactyls of America, that all thus far discovered are without teeth: a fact in strong contrast with those in other parts of the world. The jaws or beaks of the American species are longer and more slender than those hitherto known, and in the opinion of Prof. Marsh, showing indications of having been encased in a horny sheath. These features were made known in an article in the American Journal of Science, vol. XI, p. 507. We also procured more perfect specimens of the smaller bones of the order from the hands and feet. A few solitary bones have been placed in this cabinet. Our collections of saurians have also given us more correct knowledge of their structure. The same may be said of turtles. Fossil fish, also, are quite numerous in the territory under examination. One fact of interest in this family was the finding of the teeth, cartilaginous jaw and vertebræ of a shark, Galeocerdo falcatus, three portions of which, I think, have never hitherto been found together. The flat porous vertebræ had occasionally been collected, but the genus to which they belonged was unknown. Several were found some years ago and placed in our cabinet, but not classified. The teeth have long been known and described.

Fossil birds were rare and valuable findings. These were generally of the order Odontonadæ, or birds with teeth. They were of two genera; in one, the teeth being placed in sockets, like mammalia, and in the other, in grooves, like many genera of fish and reptiles. Several new species were added to science, and more perfect specimens of Hesperornis were collected the past summer than ever before. Perhaps it may not be amiss to add that birds with teeth have been found only in the United States, and one genus, the Icthyornis, only in Kansas. Thus, our fossil pterodactyls have no teeth, and our birds have, in direct contrast with those found in other parts of the world.

We confess, in closing, that the great pleasure of our employment in thus unfolding the geological wealth of Kansas, is mingled with regret that these valuable specimens, amounting to some six or eight tons, have gone out of the State to enrich an institution already possessing one of the best collections in the world, while our own cabinets, private and institutional, are yet meager in these vertebrate remains, and perfect specimens of which no future explorer can hope to procure by going over the same grounds.

CLIMATE AND BRAINS.

By M. V. B. Knox.

"The general aspects of nature, the climate, and the scenery," says B. F. Cocker, "exert an appreciable and acknowledged influence on the mental characteristics of a people." Mitchell says: "A hot climate and a bounteous soil, where but little labor is needed to procure the necessaries of life, tend to enervate the body and mind; but a temperate clime, where the hand and head must be constantly at work, is favorable at once to physical, intellectual and moral development." "With the tropical man," says Guyot, "the life of the body overmasters that of the soul; the physical instincts of our natures those of the higher faculties; passion, sentiment,

imagination predominate over intellect and reason; the physical faculties over the active faculties. In the temperate climates, all is activity, movement. Here physical nature is not a tyrant, but a useful helper; the active faculties, the understanding and reason, rule over the instincts and the passive faculties; the soul over the body. In the frozen regions, man contends with a niggardly and severe nature. It is a desperate struggle for life. No higher culture is possible under such unfavorable conditions."

The student of history can at once see the truth of these statements. No nation great in moral and intellectual development exists or ever has existed in a purely tropical or frigid climate.

The discussion in this paper will seek the relation between climate and brain-power and products, and this ultimately with reference to Kansas.

Herschell defines the climate of a country as the result of all the meteorological influences to which it is habitually subjected. "Climate," says Humboldt, "indicates all the changes of the atmosphere which sensibly affect our organs, as temperature, humidity, variations in barometrical pressure, the calm state of the air, or the action of opposite winds; the amount of electrical tension, the purity of the atmosphere, or its admixture with more or less noxious, gaseous exhalations; and finally, the degree of ordinary transparency and clearness of the sky, which is not only important with respect to the increased radiation from the earth, the organic development of plants, and the ripening fruits, but also with reference to its influence on the feelings and mental conditions of man."

Brain-power may mean that activity of the mind which shows itself in various great productions, as literature, art, architecture, conquest, or civilization. Any one of these marks great intellectual power, though some more than others. A statue, a temple, or a campaign, may, in its conception and finish, be a poem; but above Phidias, Cheops and Alexander, tower Homer, Shakespeare and Milton. Products of pure mind justly rank above those in which the conception is carried out only by vast physical aid. The writings left by the Greeks are worth more to us than their sculpture and temples. It is interesting to trace the gradual change in brain-products from very ancient times to later, and see that they not only change from the gross to the finer, but the locality of them is from warmer climates to colder. This will be seen by glancing at some of the most noticeable instances.

Egypt, with its very ancient civilization, in a mean temperature of about 72° Fah., principally gave expression to its brain-activity in gigantic pyramids, huge sculpture, massive temples, Sesostris-like conquests, and the elements only of the arts and sciences. The climate seems to have been too warm for great mental activity and acumen, though the extremely dry atmosphere gave the ancient Egyptians advantages in this respect superior to many of their neighbors. When they no longer had princes able to lead to conquest, or to build vast pyramids, the ease with which they could procure a living from their rich valley allowed them to fall into habits of indolence and into enervation.

India, in similar temperature, but with damper air, later produced the fantastic civilization of the Ganges and Punjaub; the light architecture, imaginative and sensual in its nature; the weird Vedas, with their glimpses of the true God, but impossible systems of cosmogony, deities, and worship. Regarded simply as a brain-product, the Vedas are greatly superior to the Egyptian Book of the Dead. But the variations of climate in India are greater than in Egypt, if we take the extended definition of climate given by Humboldt. It will be noticed that reference is made to the influence of

climate, only, on the intellectual powers, it not being the design to involve the peculiarities arising from race, the extraneous influences of national relations, or the manifest destiny of nations. God is in history, but not to the total exclusion of many surrounding influences.

Passing from these hot latitudes, let us glance at the climate and intellectual force of the Greeks. Instead of a temperature ranging from 72° to 75° Fah., it averages ten degrees less; a country not of broad plains and great rivers, but one of narrow vales, short, rapid streams, indented seacoasts, beetling cliffs and snow-capped mountains. Here were clear skies, equable temperature, variety of products, a soil not so rich as to breed habits of indolence, alternating sea breezes and bracing mountain air, all combining with nobleness of race and high destiny, to place the Greek people where it could achieve prodigies of brain-product. How nobly it did this is shown by advanced civilization, arts, laws; its unrivaled architecture and statuary; its grand literature of poems, history and philosophy. But an imaginative, sensual element enters into every Greek production.

In Italy the climate is even nearer perfection. "Varro preferred the climate of Italy to that of Greece, as producing in perfection everything good for the use of man." If it lacks the grand, rugged mountain scenery of Switzerland, it has enough mountains to give great variety, with wildly romantic valleys between them. On all sides the sea reflects the sun's bright rays; now sea breezes, now mountain zephyrs dally with the luxuriant foliage of the oak, chestnut, mulberry and vine. Here brain-products were on a vaster scale, with more patience in working them out, broader culture, especially in law and general knowledge. But when in the Roman Senate there was no longer the cry of Cato that Carthage must be destroyed, when wealth and luxury and possibility of ease did their deadly work on the Roman character, the climate, too warm and humid to drive or invite to hard mental labor, allowed the scepter to depart from Italy, and now it is upheld by a sturdier race in a colder climate.

France may next claim attention. Here the climate is a little colder than in Italy, ranging from 60° in the south to 50° in the north. Zones of olive, maize, vine, small grains, succeed each other. The climate is modified by proximity to the sea and to mountain ranges. From the various climatic influences, genial and sunny, there could be expected a literature sparkling and vivacious, and such the French have produced. In other things beside literature, similar results have arisen from brain-power. The names of Rousseau, Voltaire, Racine, Moliere, De Stael, Lamartine, suggest graceful, racy, but not profound productions. Doubtless France has passed the zenith of her glory in brain-products.

To find the peoples who are most prolific in brain-work, it is necessary to go to colder and more northern climates. Justly, Great Britain and Germany can lay claim to preeminence. England, near the center of the temperate zone, is, by its insular position, never subjected to extreme climatic changes, and grows food eminently fitted to produce a robust physique—not food so much to pamper the appetite as to satisfy the demands of a rigorous climate. The names of such men as Spenser, Milton, Shakespeare and Gibbon will ever be abundant proof of England's intellectual grandeur. In one corner of Great Britain lies plucky little Scotland, "where to a late period a scanty population rescued itself from want or barbarism by determined and intelligent industry." Scotland has given to the world James Watts, Burns, Hume, Scott, Macaulay, Livingstone and Carlyle. It is generally recognized, even by Englishmen, that she produces

a superior race of men; and to what is this fact due more than to her cold bracing mountain air and severe climate?

In Germany, now the acknowledged store-house of ideas, producing more and better brain results, possibly, than all the rest of the world, the climate is cold and exacting. The temperature is eight or ten degrees lower than in France, and equal to that of Scotland. The Vosges and Hartz Mountains, with their spurs, make Germany a country of mountain air. The climate is more continental than in Great Britain, which is possibly an advantage to brain-workers. Here Luther, Richter, Göthe, and Schiller lived and wrote; and their peers are toiling on to-day, finding the cool, bracing climate a most vigorous energizer to hard work. The productions are not so spontaneous as to beget indolence, and reaction of the human system against the cold sets the powers of the mind into vigorous action. Not alone to her climate does Germany owe her wonderful brain-products, unrivaled in time, but largely to it. These northern nations, France, Great Britain, and Germany, present mental results that are less fanciful than those of the ancients. Facts are reached by the inductive method; a purer philosophy and nobler religion are believed in; imagination is rich and varied, but not wild and sensual; patient and extended research mark the labors of the plodding brain-workers of Western Europe.

In America the influences of climate are plain to all. Of one race, the settlers of Jamestown and Plymouth began their work; but if the New Englanders had to contend with greater privations and a colder climate, they were repaid for it by largely giving thought to the nation. New England principles and ideas are not mere expressions— they are freighted with meaning. Are the incompatible characteristics of the two sections of our country traceable so much to anything else as to influences of climate? Slavery was once in Massachusetts as well as in South Carolina. The climate and productions; the sense of right, born of a vigorous conscience and healthy brain; the predominance of reason and intellect over the imagination and passions, as Guyot explains—all, no doubt, had to do with this difference. In the North, man's character and activities, under the grayer skies and severer climate, are more in his control; while the fiery Southron is impatient at the Northerner's slowness. But American literature, as such, has almost all grown up north of 55° Fah., which is near Mason and Dixon's Line. Edwards, Webster, Bancroft, Prescott, Motley, Irving, Emerson, Hawthorne, Whittier, Longfellow—names to live as long as America lives—are all Northern men, and have few compeers in the warmer, enervating Southern States.

After these reviews, the question naturally arises, What of Kansas? Will her climate probably be productive of brain creations or not? The mean temperature at Lawrence, for eight years, has been 52.82° Fah. Somewhat warmer than New England and Scotland, those centers of mental activity; the former being at Boston 47, and at Edinburgh 46° Fah. It is almost exactly the temperature of Berlin, the center of German activity, and of London, the center of English activity. The extreme heat of the summer is almost continually relieved by breezes, but for which vigorous mental and physical activity would be at times almost totally cut off. As it is, more or less enervation is felt by people from a cooler climate. It is feared by many that this is leading to habits of indolence, especially in the influence of three or four summer months. Yet to say, in face of the vast crops and general improvements, both private and public, that the people of Kansas are much given to indolence, would be folly. It may be feared, however, that keenness of mental energy is somewhat dulled by the

heat. To be productive in brain-work, not only is keen energy demanded, but impassionate patience. The production of a single book has often cost long years of continuous work. Will Kansas climate invite to such patient plodding.

Possibly another cause for fear is the ease with which simply a living is gained. Not nearly as much toil, care and economy are called for here to gain a living as in New England. History shows that when a people can easily get a competency, or wallow in wealth, degeneracy of mind follows. Note the commencement of degeneracy in Egypt, Persia and Rome. No age in English literature has equalled that of Eilzabeth. Yet Englishmen had to work much harder then than now. Will lack of necessity for hard toil be a bar to mental creation in our State? Thinking of these things, I have wished that some superfluous spurs from the Rocky Mountains were set down in the middle of Kansas. When we think of the hectic literature growing up among the foot-hills of the Himalayas, the Ghauts and the Zendavesta in the eastern highlands of Persia, the Hebrew scripture in the hill-country of Palestine, of Greek and Latin classics among the mountains of Greece and the Apennines, the literature of France, Great Britain and Germany, in countries, many parts of which are broken with high hills and rugged mountains, of New England, New York and Ohio, all of them hilly and mountainous, we can sigh for the subtle something hanging above these mountains—the bracing air, the intoxication of their fresh breezes, or varied scenery, that some way has given birth, has shaped and vivified the best brain and heart productions for four thousand years. Yet there is a quiet, luxuriant beauty to our landscapes of extended prairie, wooded streams and bluffs, that may partially replace the lack of mountain scenery.

It has been suggested by Prof. F. H. Snow, that the general dryness of the atmosphere in Kansas may prove favorable to brain-workers. It is a well-known fact that one is languid, and persistent work is repugnant to him, when the air is more than usually humid. The amount of ozone is greater here than in Michigan, and possibly in other States, as shown by Prof. Kedzie's paper on Ozone, in this Academy. Quite probably, this element will prove conducive to a great mental activity. Those familiar with the history of literature, will remember that when men are settling a country there is little chance for pure mental products. With other things, their minds are absorbed in organizing, building, shaping. Thought is like carbon: to crystalize into the diamond it needs time, and most favorable of surrounding influences. Yet the very fusion of so many diverse characteristics of blood, locality and nationality, may yet place Kansas mental products in an enviable place. Give us time, and Kansas may be the Athens of America.

The attention paid to the machinery of mental development here is praiseworthy. School-houses and colleges have sprung up on every side, and newspapers have multiplied. Of the latter, in 1874, there were more than one hundred and fifty. No doubt, any one familiar with Eastern education is grieved at the lack of thoroughness in our public schools. As the students are passed up into the colleges, this lack is often painfully apparent. Why? Does the climate beget habits of mental laziness? Possibly, however, it is owing to the lack of time for the crystalization of the system. We must not be deceived by the number of schools and colleges: the work accomplished in them is the true test of mental capabilities. There is lack, too, in the number of students attending the various colleges of the State. As near as I can reach number, in eleven State and denominational

colleges in 1874, there were, including preparatory and collegiate departments, only about fourteen hundred students, by far the greater number of these in the lower grades of preparatory. It is found difficult to induce students to take extended classical or scientific drill. In closing this paper, I am glad to quote the opinion on this subject of a teacher known to you all, Dr. Marvin: "I had almost reached the conclusion that in Kansas we had struck the golden mean. The students with whom I had to do in Allegheny College were better drilled in the elements of education than most who come to us here. Our students certainly show a mental vigor, as a body, equal to any with whom I have met, in an experience of twenty-nine years of seminary and college labor. The students, as I know them in Keeseville Academy, Clinton county, New York, were quite as lively at ball, especially foot-ball, but not better in algebra. This is as I seem to see them in 1839. I doubt whether we yet have age and solidity enough in society here, to determine scientifically the merits and demerits of our climate or brain ability."

Baldwin City, Kansas, November, 1876.

BISON LATIFRONS IN KANSAS.

By B. F. Mudge.

In his monograph on the American bison, Prof. J. A. Allen has given a description of two species of extinct buffalo, viz.: B. latifrons and B. antiquus. Of these, the former is the largest, the rarest, and the most remarkable. No entire or half skeleton exists, and it has been found in four only of the United States. Even single bones are rare. It therefore becomes of interest to preserve every fragment of this gigantic animal. A few months ago, a horn-core of B. latifrons was fished from the bed of the Big Blue river, a few miles from Manhattan, Kas. We give its measurements as follows, viz.:

Length on the convex side	31	inches.
Length on the chord of the arc	22	inches.
Circumference 3 inches from the base	16½	inches.
Circumference 10 inches from the base	13	inches.
Circumference 14 inches from the base	12	inches.
Circumference 24 inches from the base	8½	inches.

Comparing these measurements with those given by Prof. Allen, we find our Kansas specimen a little shorter, more slender, and more curved than his. This would indicate the Kansas horn-core to be from a female. About an inch had been broken from the tip. If we restore this, and add the horn—which was rather slender—and the breadth of skull, we shall find that the distance from tip to tip will be over nine feet. The weight of B. latifrons was about four times that of the living buffalo. One other specimen has been found in Texas. As yet, these two are the only specimens of B. latifrons that have been discovered between the Mississippi river and the Rocky mountains.

HABITS OF THE PRAIRIE DOGS.

By H. A. Brous.

Prairie dogs have been the subject of many wild speculations. Much has been given to the public as facts concerning these interesting animals

that is purely imaginative. Each of the several species have habits nearly identical, modified by the country in which they live. These animals are widely distributed over the western Territories, extending from Texas to Minnesota. For the last four years we have studied their habits, and the following are most noticeable. They are quite prolific, bringing forth from four to six each season. The young are first observed early in May, and continue to appear throughout the month. They grow very rapidly, the pairing season being early in the fall. Until the following spring the young remain with the old dogs. Their holes are peculiarly constructed. For a few feet only the inclination is very great. That these holes communicate with others is obvious. When water is poured into one hole, the dog is often driven out of the entrance of its neighbor's house, some distance off. The amount of water that has been emptied into a single hole would go to disprove the non-communication, save above ground, with its neighbor. That the holes always communicate by subterranean passages, is not to be insisted on. Where the village is scattered, the greater would be the isolation. Naturally in a crowded town the dogs would have free and convenient passages below as above ground. Whenever their holes are in any way disturbed, the dogs repair the damages as speedily as possible. Early after a rain, as before, the villagers closely inspect their homes, to see that all is in proper shape, carefully arranging anything that is amiss. Banks surrounding the holes are kept higher than the surface of the ground, in order that the water may be prevented from filling the holes. In case of a leak, they will sometimes go out during a storm and repair the break. Tall weeds, grass, or anything growing on the "town site," that is apt in any way to obstruct their view, are cut down many times in the season, and left scattered quite thickly over the lots.

What is strangest of all is to see an owl wisely standing at a dog-hole, ducking its body as you attempt to approach. No less surprising is it to hear the startling warning from a large rattlesnake, and see it crawl safely into a hole beyond your reach. Dogs suffer more from the snakes than from the owls. The latter seek old abandoned holes, where they may take shelter and rear their brood. The darkest and deepest are not sought by the owl. They are contented to find a retreat near the surface of the ground. That owls prey on the young dogs is not to be doubted. While very young the dogs do not venture far from their mother, remaining in the holes during the night, while the owls are most active. In body these birds are smaller than quails. The old dogs are seldom attacked by the owls, and seemingly pay little attention to them after their young are old enough to shift for themselves. In the rattlesnake they find an enemy not so readily treated. No hole is secure; day and night the dogs are harassed of this, their worst and deadliest foe. Deep holes are retreats admirably adapted to the wants of the rattlesnake during the long winter months, where he finds a dry bed already prepared, and palatable meals furnished by the young, tender dogs. Thus the old dogs are subjected to great inconvenience, and, in an encounter, though they may drive the intruder from their holes, are sure to be left in a dying condition. More than once, after seeing a snake enter a prairie dog's hole, have I heard a struggle away down near the bottom. Often the dog is driven out, and dies of its poisonous wounds, or, after the snake has left, it succumbs, to be at last carried from its home by the remaining members. (The dogs carry off all effete matter.)

Sometimes, should the snakes venture into a hole where the occupants have been able to make good their escape, they may be conquered. The dogs seem to hold a sort of council for a few minutes, and then commence

filling up the hole he entered. In this way they very soon completely bury the snake alive, without subjecting themselves to any danger. During this operation the snake keeps up a constant threatening.

No animal has been able to do without water for any protracted period. Now, are we to suppose that prairie dogs are exceptions? While in a cage they partake of water freely, and when it is withheld for any length of time, they become languid and die. May we not conclude that in their prairie towns they have an underground passage to water? The country on which the villages are usually located does not in any way go to disprove it. Geographically, the idea and evidence strongly aid. Rain is too uncertain, and in most cases is brief and long deferred; so that to suppose an animal could endure the protracted drouth, where dews are very light or wanting, is decidedly improbable, to say the least. If not by such wells, when surface water is miles from the villages, in what other way can water be obtained?

HABITS OF AMBLYCHILA CYLINDRIFORMIS.

By H. A. Brous.

DESCRIPTION.

A. cylindriformis Say. Color, pitch black; elytra often brownish. Labrum with two obtuse teeth at middle. Head as large as the thorax; smooth. Eyes small. Thorax subcordate, margin not prominent, surface smooth, impunctured, subapical transverse impression faint. Elytra oblong, nearly twice as long as wide, humeri broadly rounded, sides feebly arcuate, apex suddenly declivous, surface coarsely but not densely punctured, and with two indistinct rows of large punctures and three fine carinæ on each side, the outer and inner extending to three-fourths, the intermediate slightly longer. Body beneath nearly smooth. Length, 1.20-1.25 inches.

Male—Hind trochanter acute and grooved. Female—Hind trochanter shorter, obtuse and smooth.

This beetle, usually considered very rare, is, I am satisfied, much more common than heretofore supposed. I base this opinion on my own observations, and have a good collection to sustain it. Their peculiar habits are evidently the great cause of their rarity, and once understood, I am positive they will become quite common. Their geographical distribution is, so far as is now known, rather limited; yet there is now no reason to suppose that they will not, eventually, be found extending over a large portion of Kansas, Colorado, northern Arkansas, and Arizona.

The following is what I have learned concerning them: Nocturnal (crepuscular), rarely being taken until after sunset, and occasionally in the morning. Found usually along clay banks, living in holes generally made by themselves, where they find that seclusion so congenial to their nature. The state of the weather affects appreciably this insect. When cold and blustery, they remain concealed, preferring a warm, balmy air; occasionally, a warm, cloudy afternoon will entice them from their retreats, but this is rarely to be expected. Like the rest of Cicindelidæ, they are predaceous. They also feed on effete matter. In many of their habits they are like Asida.

THE WACONDA METEORITE.

By Prof. G. E. Patrick.

Some few weeks ago, a stone of about thirteen pounds weight was placed in my hands by Prof. J. S. Shearer, of the University, with a statement that it was a fragment of a much larger rock, found at Waconda, Mitchell county, and with the request that I should examine into its composition and nature. This I proceeded at once to do, and a very brief examination convinced me that I had a fragment of an aerolite (air stone, literally), or stony meteorite; this term being included, together with two others, aero-siderite and aero-siderolite, under the class title, meteorite.* Its fractured surface, laid bare in breaking it from the original mass, is of a light gray color, showing numerous small particles of nickeliferous iron, and occasionally a nodule of troilite (meteoric sulphide of iron, Fe S.)

Its original surface (for the fragment under examination happened to be an outside piece of the original stone) shows the characteristic black crust, the result of superficial fusion. No free carbon could be detected. A small piece of the stone placed in water, under the receiver of an air-pump, evolved gas quite copiously upon exhaustion; the character of this gas was not studied, but it is undoubtedly composed largely of hydrogen.

An average fragment of the size of a hen's egg was taken for the determination of specific gravity. The precaution advised by Prof. J. L. Smith was observed, namely, that of freeing the stone of inclosed gases before weighing in water, by placing it, immersed in water, under the receiver of an air-pump, and exhausting. The specific gravity thus obtained was 3.49. Next the percentage amount of the nickeliferous iron was determined by repeated extractions from the finely-powdered stone with a magnet, the magnetic portion being in turn repeatedly powdered and reexhausted with the magnet. 183.550 grammes of the stone treated in this way yielded 16.950 grammes; that is, 9.23 per cent. of nickeliferous iron, freed from impurities as perfectly as was possible by physical means. This iron was malleable even when dry, very tough, and of bright metallic luster. A portion of it was subjected to analysis, and yielded the following results:

Sulphide of iron	A trace, undetermined.
Iron	90.47
Nickel	7.81
Cobalt	1.72
	100.00

Of the history of the stone little is known. For the few facts I have been able to obtain concerning it, I am indebted to its possessor, Dr. Geo. W. Chapman, of Waconda. The weight of the stone when secured by him, in 1873, was about 120 pounds.* Several persons remember to have seen it in the same locality as early as 1870, at the time of the first settlement of the town, but at that time it attracted no special attention. Dr. Chap-

*In dividing meteorites into these three groups, the distinguishing feature lies in the relative amounts, and arrangement of the iron and stony material (silicates), which they contain. All contain native iron. which. by the way, is almost invariably associated with nickel and cobalt. An aerolite is a meteorite composed chiefly of stony material, but containing nodules of nickeliferous iron distributed through its mass. An aero-siderite is one whose bulk is composed of solid nickeliferous iron, with little or no stony matter adhering. And the aero-siderolite is an intermediate variety, of very rare occurence, in which the iron, forming a skeleton, is honey-combed in every direction by the stony portion.

*That I infer was its original weight when it fell; but of this I am not certain.

man also informs me of a fact of which I was ignorant until after my examination was completed, namely, that the stone had been recognized as a meteorite by Prof. C. U. Shepard, Sr., and also by Prof. J. L. Smith, each of whom had obtained a specimen of it.

THE IOLA GAS WELL.

By Prof. G. E. Patrick.

A recent visit to the locality, and a chemical examination of the water, enable me to present a few facts concerning the very interesting natural phenomenon which forms the subject of this paper.

The Iola gas well or mineral well is situated at Iola, Allen county, Kansas, on the line of the Leavenworth, Lawrence & Galveston Railroad. It was sunk in the early part of 1873, not as a well, but as a boring for coal, the occurrence of which as an underlying deposit of that section of country was thought quite probable, though not at all certain, by those best versed in Kansas geology.

A cylindrical diamond drill was employed; and the core taken out, representing the numerous and varied strata passed through, forms an interesting stratigraphical study. The drill was put down 400 feet, and no coal-bed of paying thickness was reached; still the pluck of the managers survived, and with exceptional perseverance they went down without encouragement over 200 feet further. But at a depth of 626 feet they met with a novel change; at that depth the drill suddenly dropped into and through a cavity of about 20 inches in thickness, and water and gas began to be forced up around the drill.

But the object of the boring being neither water nor gas, but coal, with almost unprecedented perseverance the company put their drill down still another hundred feet, but without success; and at a depth of 736 feet gave it up as a lost cause.

The flow of water and gas that commenced at a depth of 626 feet, has continued ever since, and it is a fact worthy of notice that the velocity of the flow has materially increased since that time, the increase being estimated by competent judges as at least 100 per cent.

Soon after the completion of the well, Prof. Stimpson, then of the State University, from measurements made on the spot, estimated the discharge of gas to be about 5,200 cubic feet per day; but from its greatly increased velocity, its daily discharge is now estimated at nearly or quite 10,000 cubic feet. Of water the yield is said to be now about 95 barrels daily.

The velocity of efflux, both of water and of gas, is not at all constant; for the flow is by intermittent pulsations, as must necessarily be the case in such a well. It is not an artesian well in any sense, as the motive power is without doubt the elasticity of the gas that is being constantly generated, or (not to exclude a possible, though I think not a probable explanation) that has been generated and stored up in past times.

This question of the time of the gas generation, whether past or present, cannot, it is true, be answered with entire confidence, but in view of the long time the flow has continued with undiminished force, I think it more than probable that through the agency of internal heat—or perhaps by slow oxidation—vegetable organic matters (common bituminous coals, perhaps) are being to-day decomposed into this light gas and other less volatile compounds. But at what depth in the earth, or how many hun-

dreds of miles away from the Iola well this process is going on, I will not venture even an opinion.

Another point still more theoretical: it seems very probable to me that the cavity found under Iola, from which water and gas are ejected, is of great lateral extent; that it was once occupied by a coal-bed, and that this coal has, as explained above, furnished the gas. The decomposing agency, heat, must then (according to this theory) have acted with considerable energy at a depth of 626 feet below the present surface of the country at Iola. But there is no evidence of extraordinary heat at this locality now; hence, to make the theory consistent with itself, we must assume that the heated area has not been permanent in position but has moved about—an assumption which I think geological science will allow.

To return now from the theoretical unknown to the actual known. The intervals of quiet between the pulsations are of course while water is accumulating in the well, and before the gas has acquired sufficient tension to hurl it out. These intervals I found to be of from 30 to 40 seconds duration; but the proprietor of the well, Mr. Acers, informed me that the duration of the interval is not at all constant, but that at night and before a storm it is shorter, and that the energy of the pulsation is then considerably increased.*

From its quality the gas is better fitted for heating than illuminating purposes, the flame yielded by it being decidedly thin, from its poverty in carbon. But if properly carbonized by passing through gasoline, it would undoubtedly become a very superior illuminating gas. As yet it has not been utilized to any extent.

I have been unable as yet, from lack of time, to examine into the composition of the gas, but hope to do so before long.

Now to turn to the water. It has had attributed to it, upon grounds which I need not here mention, rather marvelous medicinal properties; and now, whatever its virtues may be, it is sold and drunk in large quantities.

The question of its value as a curative agent I do not propose to discuss—that is left with the doctors and the people—but only to give a report of its mineral constituents, and let others decide whether they are medicinal or not. The total solid residue upon evaporation is 16.504 grammes per litre of the water. The ingredients and proportions are as follows. The carbonates of the residue are present in the water as bicarbonates: †

	Grammes in 1 litre of water.
Sodium Chloride, Na Cl. (Plus K Cl. small amount)	15.010
Calcium Chloride, $Ca\ Cl_2$	.543
Magnesium Chloride, $Mg\ Cl_2$	.624
Ferrous Carbonate, $Fe\ CO_3$	.023
Calcium Carbonate, $Ca\ CO_3$	.272
Sodium Sulphate, $Na_2\ SO_4$	.019
Sodium Bromide, Na Br	.004
Silica, $Si\ O_2$ (possibly combined with Na)	.009
Total solids	16.504

*It is suggested that this phenomenon is caused by the variation in atmospheric pressure. Other similar instances have been reported.

†Because the metric system of weights and measures is used in preference to all others in science, and more especially because it should be used in this country as well as in all others for commercial purposes, I use it here. These figures are of course easily convertible into terms of grains to the gallon, remembering that 1 gramme equals 15.4323 grains; and that 1 litre equals 1.05672 quarts, U. S.

The water also holds in solution a small amount of the hydrocarbon gas (together with carbonic oxide, oxygen and nitrogen), but this seems not to decompose at all during evaporation, as it does not contaminate the solid residue.

The temperature of the water as it issues from the well is constant throughout the year, and is about 61° Fah.

LIST OF COLEOPTERA.

Collected in Colorado in June, July and August, 1876, by the Kansas University Scientific Expedition.

By Prof. F. H. Snow.

Five members of the class of 1876 of the University of Kansas, after commencement, organized a scientific expedition for explorations in Colorado, and invited me to accompany them. The names of the students were as follows: George F. Gaumer, Charles W. Smith, Elmer B. Tucker, Miss May Richardson and Miss Lizzie Williams. My wife and son were also members of the party, Large collections were made of insects, plants, birds, mammals and reptiles, the chief attention being devoted to the first two of these departments. A few minerals were also collected. Three weeks were spent at Colorado Springs, from which point excursions were made to the Plains on the east, to the summit of Pike's Peak, Chiann Canon, and various other localities. Three weeks were devoted to an expedition to the South Park by way of the Ute Pass. During the first week in August the students returned home, but the rest of the party remained in camp in Engelmann's Canon, along the trail of Pike's Peak, until September 1st, making large collections of insects.

Of the material thus accumulated, I have as yet had time to "work up" only a single order of insects, the Coleoptera. In this order three hundred and four species and twelve varieties were collected; among them twelve new species, and one of Thomas Say's "long-lost" species (Dictyoptera sanguinipennis). The list includes a few species taken by Mr. Edwin A. Popenoe, of Topeka ,who spent two weeks in Colorado, and was with us for a single day at Colorado Springs.

For the determination of a large proportion of the species not previously in my collection, I am indebted to Dr. John L. LeConte, of Philadelphia, who will describe the new species discovered by our party. The number prefixed to the names are those of Crotch's "check-list." Instead of using the word "rare" to denote infrequent occurrence of a species, I have preferred to mention the exact number of specimens in each case obtained.

LIST.

CICINDELIDÆ.

1. Amblychila cylindriformis, Say. A single specimen was found dead in a spider's wel, in Webster Park, by Mr. Popenoe The rarity and value of this insect may be inferred from the fact that $12 are asked for a single specimen by Eastern dealers.

12. Cicindela longilabris, Say var. South Park, sandy plains, common; differs somewhat from the type-form.

22. Cicindela purpurea, Oliv. var. Audubonii, Lec. South Park; same localities as the preceding.

23. Cicindela cimarrona, Lec. South Park, with the preceding. A large series of the last two forms was taken, convincing Dr. LeConte of what he had long suspected, that they should not be considered distinct species.

25. Cicindela venusta, Lec. A single specimen only, on the plains near Colorado Springs.

27. Cicindela fulgida, Say. Banks of the Platte, in South Park; only five specimens.

28. Cicindela tranquebarica, Hb. var. Two specimens.

30. Cicindela 12-guttata, Dej. Abundant

at Manitou and vicinity.

30b. Cicindela guttifera, Lec. Same localities as the preceding.

37. Cicindela cinctipennis, Lec. Only five specimens; locality not noted.

51. Cicindela punctulata, Fab. Abundant everywhere.

51a. Cicindela micans, Fab. A green variety of the preceding; not uncommon.

CARABIDÆ.

84. Elaphrus Californicus, Mann. One specimen only, at Manitou.

173. Cychrus elevatus, Fab. Two specimens only, taken in our tent at Engelmann's Cañon.

200. Pasimachus elongatus, Lec. Found abundantly under cattle "chips," near Colorado Springs.

340. Loxopeza grandis, Hentz.

344. Loxopeza atriceps, Lec.

394. Glycia purpurea, Say. Of each of the last three species, a single specimen only was obtained; locality not noted.

397. Cymindis laticollis, Say. South Park; not common.

398. Cymindis brevipennis, Zimm. South Park; abundant under "chips."

399. Cymindis abstrusa, Lec. Found with the preceding species, and now considered identical with it by Dr. LeConte.

428. Calathus ingratus, Dej. Three specimens.

436. Calathus dubius, Lec. Five specimens.

511. Platynus cupreus, Dej. Two specimens.

514. Platynus placidus, Say. Two specimens.

520. Platynus obsoletus, Say. One specimen.

563. Evarthrus incisus, Lec. Abundant under "chips," near Colorado Springs.

581. Pterostichus protractus, Lec. Three specimens.

— Pterostichus longulus, Lec. One specimen.

679. Amara hyperborea, Dej. Three specimens, found a short distance below the summit of Pike's peak, 14,000 feet above the sea. This species is also found on the summit of Mt. Washington, in New Hampshire.

694. Amara impuncticollis, Say. Five specimens.

— Amara sp. An undescribed species, not uncommon.

699. Amara fallax, Lec. Abundant under "chips" near Colorado Springs.

706. Amara interstitialis, Dej. Two specimens.

712. Amara chalcea, Dej. One specimen.

717. Amara gibba, Lec. Common under "chips."

815. Nothopus zabroides, Lec. Ten specimens.

818. Cratacanthus dubius, Beauv. Two specimens.

819. Piosoma setosum, Lec. Taken at Alpine by Mr. Popenoe.

834. Discoderus parallelus, Hald. One specimen.

872. Xestonotus lugubris, Dej. Five specimens.

925. Harpalus retractus, Lec. Two specimens.

926. Harpalus amputatus, Say. One specimen.

936. Harpalus spadiceus, Dej. Three specimens.

939. Harpalus pleuriticus, Kirby. One specimen.

945. Harpalus ellipsis, Lec. One specimen.

956. Harpalus oblitus, Lec. Eight specimens.

961. Harpalus basilaris, Kirby. Eight specimens.

—— Harpalus n. sp. One specimen.

1033. Bembidium bifossulatum, Lec. Abundant in moist places on the plains east of Colorado Springs.

1055. Bembidium Nebraskense, Lec. One specimen.

1067. Bembidium lucidum, Lec. One specimen.

1080. Bembidium cordatum, Lec. Not common, in same localities with 1033.

—— Bembidium sp. Two new species, each represented by a single specimen.

DYTISCIDÆ.

1255. Hydroporus tristis, Payk. Taken abundantly in the Ute Pass from the water below Bridal Veil Falls.

1317. Rhantus binotatus, Harr. One specimen.

1334. Ilybius biguttalus, Germ. Abundant below Bridal Veil Falls.

—— Gaurodytes sp. An undetermined species, one specimen.

1381. Anisomera cordata, Lec. Seven specimens.

STAPHYLINIDÆ.

1656. Atemeles cavus, Lec. Taken at Pueblo by Mr. Popenoe.

1771. Creophilus villosus, Grav. Common.

—— Philonthus sp. An undetermined species, one specimen.

1961. Oxyporus (near) 5-maculatus, Lec. Two specimens.

—— Anthobium sp. A single specimen, provisionally referred to this genus.

SILPHIDÆ.

2178a. Necrophorus Hecate, Bland. One specimen.

—— Necrophorus Hecate var. Several specimens.

2185. Necrophorus tomentosus, Web. Several specimens.

2188. Peltis lapponica, Hb. Abundant everywhere.

2195. Peltis ramosa, Say. One specimen.

DERMESTIDÆ.

2392. Dermestes marmoratus, Say. Abundant.

2395. Dermestes nubilus, Say. Common.

2406. Attagenus megatoma, Fab. Taken at Pueblo by Mr. Popenoe.

2434a. Orphilus subnitidus, Lec. Common.

ENDOMYCHIDÆ.

2441. Mycetina morosa, Lec. A common intruder in our camp, attacking the hams.

EROTYLIDÆ.

2537. Triplax thoracica, Say. Common upon fungi.

2541. Cypherotylus Boisduvali, Chev. Common upon pine fungi, upon which both larva and imago feed.

TROGOSITIDÆ.

2682. Trogosita virescens, Fab. One specimen.

2688. Tenebrioides corticalis, Mels. Two specimens.

2699. Ostoma ferruginea, Linn. Four specimens, taken under pine bark in Engelmann's Cañon.

2703. Calitys scabra, Thunb. One specimen on pine bark in Chiann Cañon.

NITIDULIDÆ.

2729. Carpophilus pallipennis, Say. Four specimens, Colorado Springs.

—— Epuræa sp. An undetermined species.

COCCINELLIDÆ.

2827. Hippodamia 5-signata, Kirby. Two specimens.

—— Hippodamia 5-signata, var. (fide Crotch.) One specimen.
2830. Hippodamia glacialis, Fab. One specimen.
2832. Hippodamia convergens, Guer. Common.
2835. Hippodamia sinuata, Muls. One specimen.
2837. Hippodamia parenthesis, Say. Abundant at Colorado Springs.
2847. Coccinella 9-notata, Hb. Not common.
2848. Coccinella 5-notata, Kirby. Common.
2858. Harmonia picta, Rand. "Not before found so far West" (Dr. LeConte); one specimen only.
2863. Anatis Rathvoni, Lec. var. Three specimens.
2872. Exochomus marginipennis, Lec. var. One specimen.
2872a. Exochomus æthiops, Bland. Three specimens.
—— Exochomus sp. An undescribed species of this genus was taken by Mr. Popenoe at Pueblo.
2882. Hyperaspis fimbriolata, Mels. Taken at Pueb.o by Mr. Popenoe.

PARNIDÆ.

2977. Helichus striatus, Lec. Abundant in the water below Bridal Veil Falls.

HISTERIDÆ.

3031. Hister instratus, Lec. One specimen.
3049. Hister abbreviatus, Fab. One specimen.
3131. Saprinus lugens, Er. Two specimens.
3133. Saprinus Pennsylvanicus, Payk. One specimen.
3134. Saprinus Oregonensis, Lec. Common.

LUCANIDÆ.

—— Platycerus sp. "Probably a new species, very close to P. depressus, but the hind angles of prothorax are obtuse; the male is required before it can be fully investigated." (Dr. LeConte.)

SCARABÆIDÆ.

3219. Canthon practicola, Lec. One specimen.
3230. Canthon hudsonias, Forst. One specimen.
3254. Aphodius (near) hamatus, Say. One specimen.
3269. Aphodius vittatus, Say. Five specimens.
3295. Aphodius Coloradensis, Horn. One specimen.
—— Aphodius n. sp. Five specimens; small, with pale elytra.
3381. Trox Sonoræ, Lec. Three specimens.
3427. Dichelonycha sulcata, Lec. Three specimens.
3429. Serica vespertina, Schon. One specimen.
3456. Diplotaxis brevicollis, Lec. Fifteen specimens.
3474. Diplotaxis atratula, Lec. Twenty specimens.
3564. Tostegoptera lanceolata, Say. Ten specimens.
3569. Polyphylla decemlineata, Say. One specimen, taken at Colorado Springs.
3597. Cyclocephala immaculata, Burm. Taken at Pueblo by Mr. Popenoe.
3609. Ligyrus gibbosus, DeGeer. Taken at Pueblo by Mr. Popenoe.
3645. Euryomia Kernii, Hald. Several specimens.
3646. Euryomia inda, Linn. Common at Colorado Springs.
3659. Cremastochilus Knochii, Lec. Two specimens.
3672. Trichius affinis, Gory. Abundant in the cañons, and on the mountains nearly to timber line.

BUPRESTIDÆ.

3689. Dicerca prolongata, Lec. One specimen.
3696. Dicerca tenebrosa, Kirby. Two specimens.
3707. Pœcilonota cyanipes, Say. One specimen.
3713. Buprestis confluens, Say. Taken at Pueblo by Mr. Popenoe.
3716. Buprestis Nuttalli, Kirby. Two specimens.
3718. Buprestis maculiventris, Say. Abundant; nearly all our specimens were taken from a single dead pine tree in Engelmann's cañon.
3719a. Buprestis Langii, Mann. One specimen, taken in Bear Creek cañon, on the trail to Pike's Peak.
3733. Melanophila atropurpurea, Say. Common upon pines.
3734. Melanophila Drummondi, Kirby. Four specimens.
—— Melanophila Drummondi, var. Six specimens.
3738. Anthaxia inornata, Rand. One specimen.
3756. Chrysobothris trinervia, Kirby. Six specimens.
3790. Acmæodera ornata, Fab. A common species at the base of the mountains.
3791. Acmæodera pulchella, Hbst. Common upon flowers in the same localities with the preceding.
3791b. Acmæodera mixta, Lec. Taken at Pueblo by Mr. Popenoe.
3816. Agrilus interruptus, Lec. One specimen.
3841. Brachys ærosa, Mels. One specimen.

ELATERIDÆ.

3902. Anelastes Druryi, Kirby. One specimen.
3925. Lacon rectangularis, Say. Taken at Pueblo by Mr. Popenoe.
3935. Alaus melanops, Lec. One specimen was taken in Chiann cañon.
4017. Elater phænicopterus, Lec. One specimen.
4036. Elater mixtus, Hbst. One specimen.
—— Elater sp. An undetermined species.
—— Athous simplex, Lec., n. sp. (Wheeler's Report.) One specimen.
4333. Asaphes coracinus, Cand. Two specimens.
4337. Asaphes memnonius. Hbst. One specimen.
4340. Asaphes decoloratus, Say var. Two specimens.

LAMPYRIDÆ.

—. Dictyoptera rubripennis, Lec. Six specimens, taken at Manitou.
—— Dictyopera ruficollis, Lec. One specimen.
4427. Cænia sanguinipennis, Say. A "long-lost species." Six specimens were taken at Manitou.
—— Cænia ——. "Probably a new species." (Lec.)
4439. Eros modestus, Say. Two specimens.
4453. Photinus nigricans, Say. Three specimens.

TELEPHORIDÆ.

4481. Chauliognathus basalis, Lec. Exceedingly abundant.
—— Podabrus lateralis, Lec. ms. A new species, first taken by Lieut. Wheeler's expedition. Five specimens were taken by our party.
4542. Telephorus fidelis, Lec. One specimen.

MALACHIDÆ.

4582. Collops bipunctatus, Say. Common at Colorado Springs.

—— Collops hirtellus, Lec. First taken by Lieut. Wheeler's expedition. We took one specimen only.

—— Pristoscelis, n. sp. Two specimens.

4683. Listrus senilis, Lec. Several specimens.

CLERIDÆ.

4716. Clerus ornatus, Say. Common upon flowers, especially upon geranium.

4736. Thanasimus nigriventris, Lec. One specimen.

4738. Thanasimus mœstus, Klug. Three specimens.

4753. Hydnocera subænea, Lec. One specimen.

4756. Hydnocera pubescens, Lec. One specimen.

4791. Corynetes violaceus, Linn. One specimen.

CERAMBYCIDÆ.

4907. Ergates spiculatus, Lec. Three specimens, taken in Engelmann's cañon.

4918. Prionus Californicus, Motsch. Ten specimens, Engelmann's cañon.

4923. Homæsthesis emarginatus, Say. Eight specimens, taken on the plains east of Colorado Springs.

4928. Asemum atrum, Esch. var. With brown elytra; a single specimen.

4930. Nothorina aspera, Lec. One specimen.

4931. Criocephalus productus, Lec. Six specimens, South Park.

4933. Criocephalus asperatus, Lec. Seven specimens, South Park.

4939. Tetropium cinnamopterum, Kirby. Two specimens.

4948. Phymatodes variabilis, Fab. One specimen.

4958. Phymatodes dimidiatus, Kirby. Two specimens.

5068. Tragidion coquus, Linn. One specimen, Engelmann's cañon.

5068a. Tragidion fulvipenne, Say. Three specimens, same locality.

5077. Batyle ignicollis, Say. Four specimens.

5081. Batyle Pearsalli, Bland. Common upon Solidago in Engelmann's cañon, Ute Pass, and other localities.

—— Xylotrechus, n. sp. Fifteen specimens, taken from pines in Engelmann's cañon.

5134. Neoclytus leucozonus, Lap. One specimen.

5180. Pachyta liturata, Kirby. Ten specimens upon pines in Engelmann's cañon.

5195. Acmæops tumida, Lec. Three specimens.

5198. Acmæops longicornis, Kirby. Two specimens.

5198a. Acmæops longicornis, Kirby var. Two specimens.

5205. Acmæops strigilata, Fab. Common on flowers, especially in cañons on eastern border of South Park.

5223. Typocerus brunnicornis, Lec. One specimen, South Park.

5224. Typocerus sinuatus, Newm. One specimen.

5229. Leptura propinqua, Bland. Common upon thistles in Bear Creek cañon, along the trail of Pike's Peak.

5249. Leptura subargentata, Kirby. Common in cañons along east border of South Park.

5250. Leptura similis, Kirby. Common in same localities with the preceding.

5257. Leptura instabilis, Hald. var. A black variety, one specimen.

5257a. Leptura convexa, Lec. Five specimens, at an altitude of 10,000 ft., upon Astragalus flexuosus.

5264. Leptura nigrella, Say. One specimen.

—— Leptura nigrella, var. A variety with testaceous elytra; one specimen, chopped from a pine log in a cañon on east border of South Park.

5266b. Leptura cribripennis, Lec. Eight specimens, taken under pine bark on eastern border of South Park, and in Engelmann's cañon.

5272. Leptura sanguinea, Lec. Rather common in cañons along east border of South Park.

5276. Leptura chrysocoma, Kirby. Common in Chiann cañon and Engelmann's cañon.

5299. Leptura aspera, Lec. Two specimens.

5306. Monilema annulatum, Say. A dozen specimens, chiefly upon Opuntia, at Colorado Springs.

5323. Monohammus scutellatus, Say. Taken abundantly upon pines in Engelmann's cañon; also in South Park.

5377. Acanthocinus obliquus, Lec. Four specimens, Englemann's cañon.

5378. Acanthocinus spectabilis, Lec. One specimen, Ute Pass—a rare species.

5381. Dectes spinosus, Say. Four specimens, Engelmann's cañon.

5387. Pogonocherus simplex, Lec. One specimen.

5388. Pogonocherus mixtus, Hald. Four specimens.

5424. Mecas inornata, Say. One specimen.

5425. Mecas pergrata, Say. One specimen.

5452. Tetraopes annulatus, Lec. Four specimens.

SPERMOPHAGIDÆ.

5472. Bruchus discoideus, Say. One specimen. "In seeds of Ipomœa leptophylla." (Dr. LeConte.)

—— Bruchus sp. An undetermined species.

5506. Bruchus seminulum, Horn. One specimen.

CHRYSOMELIDÆ.

5535. Orsodachna Childreni, Kirby. Common upon Pike's Peak.

—— Orsodachna Childreni var. A black variety.

—— Zeugophora n. sp. Common upon Populus tremuloides along the Ute Pass road, near "Castellar's."

5564. Saxinis saucia, Lec. Two specimens. "Not before found so far east." (Dr. LeConte.)

5574. Coscinoptera vittigera, Lec. Rather common in South Park, near Girten's Sulphur Springs.

5609. Cryptocephalus notatus, Fab. One specimen.

5642. Pachybrachys atomarius, Mels. Three specimens.

5661. Pachybrachys litigiosus, Suffr. One specimen.

5664. Pachybrachys hepaticus, Mels. One specimen.

—— Pachybrachys sp. An undetermined species.

5665. Adoxus vitis, Linn. Three specimens, taken above timber line on Pike's Peak.

5672. Heteraspis marcassita, Germ. One specimen.

5688. Chysochus auratus, Fab. Rather common at Colorado Springs.

5719. Colaspis tristis, Oliv. var. (fide Crotch). Two specimens.

5729. Chrysomela exclamationis, Fab.

Common at Colorado Springs upon Helianthus lenticularis.

5730. Chrysomela conjuncta, Rog. var. pallida. One specimen at Colorado Springs.

5750. Chrysomela (near) auripennis, Say. One specimen; elytra more finely punctured than in the typical form.

5751. Chrysomela inornata, Rog. One specimen.

—— Chrysomela n. sp. One specimen.

5754. Gastrophysa dissimilis, Say. Two specimens.

5791. Luperus cyanellus, Lec. Several specimens.

—— Luperus sp. An undetermined species.

5800. Diabrotica tricincta, Say. One specimen at Colorado Springs. Taken also at Pueblo by Mr. Popenoe.

5811. Diabrotica atripennis, Say. Two specimens.

5831. Monoxia debilis, Lec. One specimen.

5834a. Trirhabda Canadensis, Kirby. One specimen.

5835a. Trirhabda luteocincta, Lec. Two specimens. "Not before found so far east." (Dr. LeConte.)

—— Graptodera sp. Resembles foliacea, but the antennæ are yellow instead of dark.

—— Graptodera sp. An undetermined species.

5886. Graptodera foliacea, Lec. Taken at Pueblo by Mr. Popenoe.

5913. Dibolia ærea, Mels. One specimen.

5942. Chætocnema denticula, Ill. Common at Colorado Springs.

5969. Microrhopala cyanea, Say. Taken at Pueblo by Mr. Popenoe.

TENEBRIONIDÆ.

5993. Edrotes rotundus, Say. Thirty specimens were taken at Colorado Springs, all of them under "chips," upon an area not more than five rods square.

6002. Trimytis pruinosa, Lec. Taken at Pueblo by Mr. Popenoe.

6029. Emmenastus acutus, Horn. Abundant under "chips," in South Park.

6068. Asida opaca, Say. One specimen only was taken at Colorado Springs. Abundant in the upper Arkansas valley, west of South Park.

6070. Asida polita, Say. Common at Colorado Springs under "chips."

6071. Asida sordida, Lec. One specimen at Colorado Springs.

6094. Asida convexicollis, Lec. Rare near Colorado Springs.

6097. Asida elata, Lec. One specimen.

6098. Ologlyptus anastomosis, Say. Taken at Pueblo by Mr. Popenoe.

6105. Eusattus reticulatus, Say. Taken at Pueblo by Mr. Popenoe.

6109. Eusattus difficilis. Lec. One specimen.

6109a. Eusattus convexus, Lec. Three specimens, at Colorado Springs.

6126. Coniontis obesa. Lec. Several specimens.

6131. Eleodes tricostata, Say. Common at Colorado Springs under "chips."

6132. Eleodes carbonaria, Say. Taken by Mr. Popenoe in Pleasant Valley, Arkansas river.

6133. Eleodes obsoleta, Say. Exceedingly abundant at Colorado Springs.

6137. Eleodes extricata, Say. Common at Colorado Springs.

6149. Eleodes nigrina, Lec. Common in South Park.

6150. Eleodes hispilabris, Say. Eight specimens, at Colorado Springs.

6165. Eleodes cordata, Esch. One specimen.

6167. Eleodes opaca, Say. Twenty specimens, found under old bones near Colorado Springs.

6202. Iphthimus serratus, Mannh. var. Common under pine bark in Engelmann's cañon.

6208. Upis ceramboides, Linn. One specimen.

6244. Blapstinus pratensis, Lec. Abundant in South Park.

6266. Tribolium madens, Charp. One specimen.

6320. Platydema Oregonense, Lec. One specimen.

ALLECULIDÆ.

6375. Hymenorus obscurus, Say. Three specimens.

ANTHICIDÆ.

6432. Stereopalpus guttatus, Lec. Three specimens.

6442. Corphyra Lewisii, Horn. Five specimens.

—— Notoxus sp. An undetermined species.

6511. Anthicus granularis, Lec. One specimen.

—— Anthicus sp. An undetermined species, probably new, two specimens.

MELANDRYIDÆ.

6578. Anaspis nigra, Hald. Abundant everywhere below timber line, upon Solidago.

6583. Anaspis rufa, Say. Common in cañons along eastern border of South Park.

6593. Mordella melæna, Germ. Common.

6594. Mordella scutellaris, Fabr. Common.

—— Mordella sp. Probably a new species. Common.

MELOIDÆ.

6701. Meloe sublævis, Lec. Common at Colorado Springs.

—— Meloe sp. An undetermined species, one specimen.

6702. Nomaspis parvula, Hald. One specimen.

6731. Epicauta ferruginea, Say. Common in Engelmann's cañon, Manitou, Ute Pass, etc.

6732. Epicauta sericans, Lec. Common.

6733. Epicauta pruinosa, Lec. This and the preceding species were found upon potatoes wherever cultivated, and upon Astragalus flexuosus in the mountains.

6738. Epicauta maculata, Say. Common.

—— Epicauta maculata var. A variety with large spots, much more common than the typical form of the species.

6750. Pyrota mylabrina, Chev. Abundant in vicinity of Denver.

6772. Cantharis viridana, Lec. Exceedingly restricted in its distribution, but found in abundance in two or three half-acre spots at an altitude of about 10,000 feet, upon Astragalus flexuosus, which seems to be the natural food-plant of several species of Meloidæ.

6791. Cantharis sphæricollis, Say. Two specimens.

6808. Nemognatha bicolor, Lec. Four specimens were taken on thistles at Colorado Springs.

6809. Nemognatha lurida, Lec. Common on thistles (Cirsium undulatum) at Colorado Springs and along the Ute Pass.

6821. Nemognatha nigripennis, Lec. One specimen.

6825. Nemognatha immaculata Say. Twelve specimens were taken at Colorado Springs.

6830. Gnathium minimum, Say. Taken by Mr. Popenoe at Pueblo.

OEDEMERIDÆ.

6841. Ditylus obscurus, Lec. One specimen.

CURCULIONIDÆ.

6953. Ophryastes vittatus, Say. Four specimens, at Colorado Springs.

6954. Thecesternus affinis, Lec. One specimen.

— Cleonus 4-lineatus, Chevr. One specimen.

7106. Balaninus nasicus, Say. One specimen.

— Balaninus quercus, Horn. One specimen.

— Acalles basalis, Lec. One specimen.

— Tricalaphus planirostris, Lec. n. sp. One specimen, described in Dr. LeConte's monograph on the "Rhynchophora of N. America," p. 413.

— Baris sp. An undetermined species.

— Aulobaris ibis, Lec. Three specimens, South Park.

7281a. Sphenophorus vomerinus, Lec., var. baridioides.

SCOLYTIDÆ.

7400. Dendroctongus terebrans, Lec. Eight specimens, at Colorado Springs.

7410. Hylastes macer, Lec. One specimen.

— Hylastes longus, Lec., n. sp. Described in Dr. LeConte's "Rhynocophora," p. 389. One specimen.

ANTHRIBIDÆ.

— Brachytarsus griseus, Lec., n. sp. Described on p. 405 of LeConte's "Rhyncophora." Taken in abundance at Girten's Sulphur Springs, in South Park, upon Actinella Richardsonii.

SUMMARY OF SPECIES

(not including varieties.)

Cicindelidæ	10
Carabidæ	42
Dytiscidæ	5
Staphylinidæ	5
Silphidæ	4
Dermestidæ	4
Endomychidæ	1
Erotylidæ	2
Parnidæ	1
Histeridæ	5
Trogositidæ	4
Nitidulidæ	2
Coccinellidæ	12
Lucanidæ	1
Scarabæidæ	19
Buprestidæ	15
Elateridæ	10
Lampyridæ	6
Telephoridæ	3
Malachidæ	4
Cleridæ	6
Cerambycidæ	40
Spermophagidæ	3
Chrysomelidæ	32
Tenebrionidæ	25
Alleculidæ	1
Anthicidæ	5
Melandryidæ	2
Mordellidæ	5
Meloidæ	15
Oedemeridæ	1
Curculionidæ	11
Scolytidæ	2
Anthribidæ	1
Total: families, 34; species	304

In order to furnish the means of estimating the success of our expedition in collecting insects, it may be stated that the number of species of Coleoptera collected in Colorado in 1873 by the Government expedition under Lieut. Carpenter, was 165. In the summer of 1872 Mr. J. D. Putnam, of Davenport, Iowa, collected 250 species in the same region.

A LIST OF KANSAS COLEOPTERA.

By Edwin A. Popenoe.

The following list of Kansas coleoptera is merely preliminary, and is given as a basis for a more complete collection and more thorough study of our coleopterous fauna, which it is hoped will be made in the course of a few years. It is based upon the species in my own collection, but the list is largely increased by contributions from Prof. F. H. Snow, of the State University at Lawrence, to whom the credit belongs where Lawrence is given as a locality. Additional species were collected by Mr. George P. Cooper, at Topeka and in western Kansas, and by Mr. T. B. Ashton, at Tonganoxie.

Acknowledgments are due to Drs. LeConte and Horn, of Philadelphia, for the determination of many species, and to Mr. Henry Ulke, of Washington City, for similar favors. I also owe thanks to Mr. A. S. Johnson, of the A. T. & F. R. R., for opportunities to make collecting trips to the western part of the State, which I have several times enjoyed.

The number of species included at present is about 1,200, and double the number may be reasonably expected after a few years longer work.

I have given any notes on the different species, as to distribution, habits, etc., that I thought would be interesting or useful.

The numbers preceding the names of species correspond to those in Crotch's Check List, the order and nomenclature of which is generally followed, except in the Rhyncophora, where the late work of LeConte and Horn has been the guide.

Topeka, Kansas, July 25, 1877.

CICINDELIDÆ.

AMBLYCHILA, Say.

1. cylindriformis, Say. Taken by Mr. George Cooper in Grove county. That collector has furnished the following notes on the habits of this interesting species: "They are chiefly nocturnal, and inhabit the sides and clayey banks of ravines, living in holes in the ground or side of the ravine. I took, in one instance, seven specimens from one hole, and have found two or three together since."

A single specimen of this beetle was found by the writer in Webster Park, Col., June, 1876.

TETRACHA, West.

9. virginica, L. Eastern Kansas; frequent. Crepuscular in habits.

CINCINDELA, L.

10. obsoleta, Say. "Sargent, Kas." (Cooper).

10b. prasina, Lec. "Sargent, Kas." (Cooper).

14. pulchra, Say. Syracuse, Hamilton county; also along line of K. P. R. W. in extreme western Kansas.

15b. rugifrons, Dej. Var. Lecontii, Hald. Lawrence.

15d. Var. scutellaris, Say. Topeka and Lawrence; is found along streams.

18. sexguttata, Fab. Eastern Kansas; frequent; prefers sunny roads and paths in woodlands.

21. splendida, Hentz. Eastern Kansas; common.

22. purpurea, Oliv. Eastern Kansas, abundant. Var. Audubonii also found with the species.

25. generosa, Dej. Eastern Kansas; var. formosa, Say. From Dodge City west.

27. fulgida, Say. Extreme western Kansas.

28. tranquebarica, Hb. Lawrence and Topeka.

30. duodecimguttata, Dej. Eastern Kansas; common on sunny banks in woodlands.

32. repanda, Dej. Eastern Kansas; common.

33. hirticollis, Say. Lawrence and Topeka. At the latter locality on sand-bars in the Kansas river; common.

43. cuprascens, Lec. Lawrence, Topeka, Hutchinson, and Rooks county. Is found on sand-bars and banks of streams.

45. macra, Lec. With the last species, and apparently more common.

46. sperata, Lec. (Var.) "Dodge City." (Cooper.)

51. punctulata, Fab. Abundant in Eastern Kansas. Taken also in various localities throughout the State. Specimens from western Kansas and Colorado are frequently strongly tinged with blue or gold-green.

60. circumpicta, Laf. "Dodge City." (Cooper.)

65. cursitans, Lec. A few specimens of this species were taken by me at Morgan City Clay county, in June, 1875.

CARABIDÆ.

OMOPHRON, Latr.

72. americanum, Dej. Eastern Kansas.

73. tessellatum, Say. Bow creek, in Rooks county.

76. nitidum, Lec. Lawrence and Bow creek.

ELAPHRUS, Fab.

85. ruscarius, Say. Eastern Kansas; common, and found on the margins of streams and other muddy spots.

CALOSOMA, Weber.

131. externum, Say. Eastern Kansas; common.

134. scrutator, Fab. Eastern Kansas; common; climbs trees and bushes in search for its insect food.

137. Sayi, Dej. Eastern Kansas; rarely found.

138. peregrinator, Guer. Western Kansas.

140. triste, Lec. Western Kansas.

141. obsoletum, Say Topeka and Lawrence.

142. semilæve, Lec. Lawrence.

143. calidum, Fab. Eastern Kansas; the most abundant species of the genus; very common in grain-fields in August.

147. discors, Lec. Lawrence.

CARABUS, L.

155. serratus, Say. Eastern Kansas.

159. sylvosus, Say. Eastern Kansas; both species are rare at Topeka.

NOMARETUS, Lec.

166. bilobus, Say. Eastern Kansas; rare.

CYCHRUS, Fab.

173. elevatus, Fab. Eastern Kansas.

PASIMACHUS, Bon.

200. elongatus, Lec. Common throughout Kansas.

205. californicus, Chd. Eastern Kansas; frequent.

SCARITES, Fab.

208. substriatus, Hald. Lawrence.

209. subterraneus, Fab. Eastern Kansas; common.

DYSCHIRIUS, Bon.

220. globulosus, Say. Eastern Kansas; common.

224. sphæricollis, Say. Topeka and Rooks county. Taken burrowing in sand-bars in Bow creek, Rooks county.

CLIVINA, Latr.

250. dentipes, Dej. Topeka and Lawrence.

259. elongata, Rand. Two specimens of a variety, taken at Topeka.

269. bipustulata, Fab. Eastern Kansas; common.

SCHIZOGENIUS, Putz.

276. lineolatus, Say. Topeka; one specimen.

BRACHYNUS, Web.

290. cyanipennis, Say. Eastern Kansas.

296. fuman's Fab. Eastern Kansas.

PANAGÆUS, Latr.

307. fasciatus, Say. Lawrence and Topeka; formerly rare, but twenty specimens were taken in the spring of 1877; they were found under stones and boards, on hillsides.

HELLUOMORPHA, Lap.

312. præusta, Dej. Eastern Kansas.
313. laticornis, Dej. Eastern Kansas; both species infrequent.

GALERITA, Fab.

317. atripes, Lec. Eastern Kansas.
318. janus, Fab. Eastern Kansas; both species common.

ZUPHIUM, Latr.

322. americanum, Dej. Topeka; one specimen.

CASNONIA, Latr.

329. pennsylvanica, L. Eastern Kansas; common.

LEPTOTRACHELUS, Latr.

331. dorsalis, Fab. Eastern Kansas; infrequent.

LOXOPEZA, Chd.

340. grandis, Hentz. Eastern Kansas; common. Flies to a light at night.
341. atriventris, Say. Eastern Kansas; more common than the last named, and has very similar habits.

LEBIA, Latr.

345. pulchella, Dej. Topeka; two specimens taken in four years; one of these was captured flying around a light at night.
349. viridis, Say. Eastern Kansas; frequently brushed from weeds and flowers, and takes wing very readily.
350. pumila, Dej. Topeka; one specimen.
354. ornata, Say. Lawrence.
356. analis, Dej. Lawrence and Topeka; rare.

DIANCHOMENA, Chd.

359. abdominalis, Chd. Eastern Kansas.
360. scapularis, Dej. Eastern Kansas; abundant under garden refuse.

APHELOGENIA, Chd.

366. bivittata, Fab. Eastern Kansas; common. Found under refuse heaps in gardens and in similar localities.
368. divisa, Lec. Lewrence.

BLECHRUS, Motsch.

382. linearis, Lec. Topeka; frequent.
384. lucidus, Lec. Topeka; frequent.
385. pusio, Lec. Topeka.

APENES, Lec.

392. sinuata, Say. Topeka.

GLYCIA, Chd.

394. purpurea, Say. Eastern Kansas.

CYMINDIS, Latr.

397. laticollis, Say. Western Kansas.
398. brevipennis, Zimm. With the last.
406. americana, Dej. Topeka; one specimen.

PINACODERA, Schaum.

411. platicollis, Say. Topeka; one specimen.

CALLIDA, Dej.

419. punctata, Lec. Eastern Kansas; frequent.

RHOMBODERA, Reiche.

423. pallipes, Lec. Topeka; one specimen.

CALATHUS, Bon.

427. gregarius, Say. Eastern Kansas.

PLATYNUS, Bon.

456. decens, Say. Eastern Kansas.
461. extensicollis, Say. Eastern and middle Kansas; common.
463. decorus, Say. With the last, and equally common.
483. punctiformis, Say. Lawrence.
487. æruginosus, Dej. Lawrence.
498. nutans, Say. Eastern Kansas.
508. octopunctatus, Fab. Eastern Kansas; common.
514. placidus, Say. Eastern Kansas; frequent.
520. obsoletus, Say. Lawrence.

EVARTHRUS, Lec.

549. seximpressus, Lec. Eastern Kansas.
557. colossus, Lec. Eastern Kansas.
558. sodalis, Lec. var. corax. Lawrence and Topeka; frequent.
561. substriatus, Lec. Western Kansas; common.
562. constrictus, Say. Rooks county and Topeka.

PTEROSTICHUS, Bon.

605. ventralis, Say. Eastern Kansas.
608. stygicus, Say. Topeka.
616. permundus, Say. Eastern Kansas; frequent.
624. Sayi, Brulle. Eastern Kansas; common.
625. lucublandus, Say. With the last, but less common.
629. caudicalis, Say. Topeka; frequent.
633. mutus, Say. Topeka.
640. erythropus, Dej. Lawrence.
642. patruelis, Dej. Eastern Kansas.
643. femoralis, Kby. Topeka; two specimens.
—— Two undetermined species.

AMARA, Bon.

673. carinata, Lec. Eastern Kansas; frequent. Often found under dead animals and the like. An undescribed Amara (near carinata) is found at Topeka and Lawrence.
682. exarata, Dej. Eastern Kansas.
685. latior, Kby. Lawrence.
688. angustata, Say. Lawrence.
694. impuncticollis, Say. Abundant throughout the State.
699. fallax, Lec. Lawrence.
702. polita, Lec. Topeka.
721. musculus, Say. Eastern Kansas; frequent.

BADISTER, Clairv.

725. notatus, Hald. Topeka; under stones, etc., in damp places. Not common.

DIPLOCHILA, Brulle.

733. laticollis Lec. Eastern Kansas; not common.
735. obtusa, Lec. Topeka; not common. Taken under stones on dry hillsides.

DICÆLUS, Bon.

740. splendidus, Say. Eastern Kansas; frequent.
745. sculptilis. Say. Eastern Kansas; frequent.
752. elongatus, Dej. Eastern Kansas; common.

ANOMOGLOSSUS, Chd.

758. emarginatus, Say. Eastern Kansas; not rare.
759. pusillus, Say. Eastern Kansas; common

CHLÆNIUS, Bon.

764. æstivus, Say. Eastern Kansas.
765. erythropus, Germ. Lawrence.
766. fuscicornis, Dej. Topeka.
768. laticollis, Say. Eastern Kansas; common.
771. lithophilus, Say. Eastern Kansas.

774. sericeus, Forst. Eastern Kansas; common.
780. solitarius. Say. Eastern Kansas; found on sand-bars, under driftwood.
781. nemoralis, Say. Eastern Kansas; frequent.
782. pennsylvanicus, Say. Eastern Kansas.
783. tricolor, Dej. Lawrence.
785. nebraskensis. Lec. One specimen taken in western Kansas (Rooks Co.)
791. impunctifrons, Say. Topeka; one specimen.
795. tomentosus, Say. Eastern and middle Kansas; common.

OODES, Bon.

805. cupræus, Chd. Eastern Kansas, on bars in Kansas River; swims readily on the surface of the water; not common.

NOTHOPUS, Lec.

815. zabroides, Lec. Western Kansas; (Cooper.)

GEOPINUS, Lec.

816. incrassatus, Dej. Lawrence and Topeka.

CRATACANTHUS, Dej.

818. dubius, Bv. Common throughout the State.

AGONODERUS, Dej.

822. lineola, Fab. Esatern Kansas; common.
824. comma. Fab. Eastern and middle Kansas; very abundant.
828. pauperculus, Dej. Topeka; common.
830. testaceus, Dej. Topeka; frequent.

DISCODERUS, Lec.

834. parallelus. Hald. Topeka and Lawrence.

ANISODACTYLUS, Dej.

843. rusticus, Dej. Eastern Kansas; abundant.
843a. tristis, Dej. Eastern Kansas.
844. pinguis, Lec. Lawrence.
845. dulcicollis, Laf. Topeka.
846. carbonarius, Say. Eastern Kansas; common.
860. baltimorensis, Say. Eastern Kansas; abundant.
871. sericeus, Harris. Eastern Kansas; common.

XESTONOTUS, Lec.

872. lugubris, Dej. Topeka; two specimens.

SPONGOPUS, Lec.

873. verticalis, Lec. Eastern Kansas; common.

AMPHASIA, Newm.

874. interstitialis, Say. Eastern Kansas; common.

ANISOTARSUS, Chd.

878. terminatus, Say. Eastern Kansas; common.
879. agilis, Dej. Topeka; rare.

GYNANDROPUS, Dej.

886. hylacis, Say. Lawrence.

BRADYCELLUS, Er.

888. dichrous, Dej. Lawrence.
890. autumnalis, Say. Lawrence.
891. badiipennis, Hald. Topeka; rare.
892. atrimedius, Say. Topeka; rare.
900. rupestris, Say. Lawrence.

SELENOPHORUS, Dej.

917. troglodytes, Dej. Western Kansas.

HARPALUS. Latr.

924. erraticus, Say. Eastern Kansas.
926. amputatus, Say. Western Kansas; also, Topeka. One specimen.
928. caliginosus, Fab. Eastern Kansas; very common.
929. faunus, Say. Lawrence.
932. pennsylvanicus, Dej. Eastern Kansas; very common in autumn.
933. compar, Lec. Eastern Kansas; equally common with the last named.
934. erythropus, Dej. Topeka; not rare.
940. herbivagus, Say. Eastern Kansas; very common.
946. cautus, Dej. Lawrence.
963. testaceus, Lec. Western Kansas, along the Arkansas river. Five specimens, taken by the writer in different localities.

STENOLOPHUS, Dej.

976. conjunctus, Say. Eastern Kansas; very abundant in winter and spring.
982. ochropezus. Say. Eastern Kansas.

PATROBUS, Dej.

992. longicornis, Say. Topeka and Lawrence.

BEMBIDIUM, Latr.

1026. inæquale, Say. Eastern Kansas; not common.
1029. coxendix, Say. Eastern Kansas and Rooks county; common.
1037. chalceum. Dej. Topeka.
1072. picipes, Kby. Lawrence.
1080. cordatum, Lec. Great Spirit salt spring. Mitchell county.
1090. dorsale, Say. Lawrence.
1097. intermedium. Kby. Eastern Kansas; common. Also taken by me at Great Spirit Spring.
1100. pictum, Lec. Eastern Kansas.
1102. contractum, Say. Topeka.
—— texanum, Chd. (Mss.) A species so named by Dr. LeConte is not rare at Topeka.
1119. quadrimaculatum, L. Topeka; common.
1122. lævigatum, Say. Eastern Kansas; not common.

TACHYS, Ziegler.

1129. scitulus, Lec. Lawrence.
1143. nanus, Gyll. Lawrence.
1145. flavicauda. Say. Topeka.
1148. tripunctatus. Say. Topeka.
1149. vivax, Lec. Lawrence.
1156. incurvus. Say. Topeka and Lawrence.
1160. dolosus, Lec. Topeka; common.

PERICOMPSUS, Lec.

1165. ephippiatus, Say. Lawrence and Topeka; rare. My only specimen was taken from the mud on the bank of a small stream.

HALIPLIDÆ.

HALIPLUS, Latr.

1175. triopsis, Say. Topeka.
—— One undetermined species.

CNEMIDOTUS, Er.

1183. duodecimpunctatus, Say. Lawrence and Topeka; rare.

DYTISCIDÆ.

ERETES, Lap.

1185. sticticus, Linn. Smoky Hill river. (Cooper.)

HYDROPORUS, Clv.

1210. nubilus, Lec. Topeka and Great Spirit Spring.
1238. mixtus, Lec. Topeka; infrequent.
1240. vittatus, Lec. Topeka; two specimens.
1246. modestus, Aube. Topeka.

CYBISTER, Curt.

1273. fimbriolatus, Say. Topeka and

Rooks county; common.

LACCOPHILUS, Leach.

1277. maculosus, Germ. Eastern Kansas.
1278. fasciatus, Aube. Topeka; very common.
1279. proximus, Say. Lawrence and Topeka.

ACILIUS, Leach.

1288. mediatus, Say. Topeka; a single specimen.

GRAPHODERES, Esch.

1294. liberus, Say. Eastern Kansas.

COLYMBETES, Clv.

1300. sculptilis, Harris. Eastern Kansas.

DYTISCUS, L.

1316. hybridus, Aube. Lawrence and Topeka.

COPTOTOMUS, Say.

1338. interrogatus, Fab. Eastern Kansas.

COPELATUS. Er.

1340. glyphicus, Say. Lawrence.
1341. Chevrolatii, Aube. Topeka; three specimens.

GAURODYTES, Thoms.

1346. tæniolatus, Harr. Lawrence.
1369. stagninus, Say. Topeka; infrequent.
—— One undetermined species.

GYRINIDÆ.

DINEUTES, MacL.

1389. assimilis, Aube. Rooks county and eastern Kansas; abundant.

GYRINUS, L.

1409. analis, Say. Eastern Kansas.
1412. minutus, Fab. Topeka; one specimen.

HYDROPHILIDÆ.

HELOPHORUS, Fab.

1423. lineatus, Say. Topeka.

HYDROCHUS, Leach.

1426. scabratus, Muls. Topeka; frequent.
1438. simplex, Lec. Topeka.

HYDROPHILUS, Geoff.

1448. ovatus, H. and G. Lawrence.
1449. triangularis, Say. Eastern Kansas; common.

TROPISTERNUS, Sol.

1450. nimbatus, Say. Eastern and middle Kansas; common. Specimens were taken by me from the Great Spirit Spring.
1455. glaber, Hbst. Less common than the last, and found in the same localities.

HYDROCHARIS, Latr.

1461. obtusatus, Say. Eastern and middle Kansas; Great Spirit Spring; common.

BEROSUS, Leach.

1476. infuscatus, Lec. Lawrence.
1477. striatus, Say. Topeka; not common.

LACCOBIUS, Er.

1480. agilis, Rand. Topeka and Rooks county.

CHÆTARTHRIA, Steph.

1485. pallida, Lec. Rooks county.

PHILHYDRUS. Sol.

1496. cinctus, Say. Lawrence.
1497. diffusus, Lec. Lawrence.
1499. perplexus, Lec. Eastern Kansas; Great Spirit Spring; common.

HYDROBIUS, Leach.

—— An undetermined species. Lawrence.

CERCYON, Leach.

—— An undetermined species. Lawrence.

STAPHYLINIDÆ.

FALAGRIA, Leach.

1596. dissecta, Er. Topeka.
1597. venustula, Er. Topeka; frequent.
—— N. sp. Topeka.

HOPLANDRIA, Kr.

—— N. sp. Topeka.

HOMALOTA, Mann.

Six undetermined species, taken at Topeka, are in my collection.

ATEMELES, Steph.

1656. cavus, Lec. Rare; taken at Tonganoxie, by Mr. T. B. Ashton; a single specimen found by me, at Pueblo, Colorado.

ALEOCHARA, Grav.

1660. lata, Grav. Eastern Kansas; common.
1662. bimaculata, Grav. Eastern Kansas.
1666. nitida, Grav. Topeka.

GYROPHÆNA, Mann.

1674. vinula. Er. Topeka.
1675. dissimilis, Er. Topeka.

LEUCOPARYPHUS, Kr.

1688. silphoides. L. Topeka.

COPROPORUS, Kr.

1691. punctipennis, Lec. Topeka.
1692. ventriculus, Er. Topeka.

TACHINUS, Grav.

—— An undetermined species. Topeka.

TACHYPORUS, Grav.

1708. jocosus, Say. Topeka.
1709. brunneus, F. Topeka.
1712. chrysomelinus, L. Topeka.
1713. maculipennis, Lec. Topeka.

CONOSOMA, Kr.

—— scriptum, Horn. Ms.
1714. crassum, Grav. Topeka; rare.
1715. basale, Er. Topeka; frequent.
—— Two undescribed species. Topeka.

BOLETOBIUS, Leach.

1726. cinctus, Grav. Topeka; two specimens.

BRYOPORUS, Kr.

—— An undetermined species. Topeka.

MYCETOPORUS, Mann.

—— One undescribed species. Topeka.

QUEDIUS, Steph.

1754. fulgidus, Fab. Lawrence and Topeka.
—— An undescribed species. Topeka.

CREOPHILUS, Kby.

1771. villosus, Grav. Eastern Kansas; common.

LEISTOTROPHUS, Perty.

1773. cingulatus, Grav. Eastern Kansas.

STAPHYLINUS, L.

1777. maculosus, Grav. Eastern Kansas; common.
1781. vulpinus, Nordm. Eastern Kansas.
1782. fossator, Grav. Topeka and Lawrence.
1784. tomentosus, Grav. Eastern Kansas.

BELONUCHUS, Nordm.

1801. formosus, Grav. Topeka.

PHILONTHUS, Leach.

1802. cyanipennis, Fab. Eastern Kansas; found in fungi and in decaying vegetable matter.
1806. cautus, Er. Topeka; two specimens.
1807. hepaticus, Er. Topeka; common.

1818. palliatus, Grav. Topeka.
1820. thoracicus. Lawrence and Topeka. Topeka.
1822. micans, Grav. Topeka.
1824. brunneus, Grav. Topeka.
1833. baltimorensis, Grav. Topeka; has the habits of cyanipennis.
1837. pæderoides, Lec. Topeka.

GYROHYPNUS. Leach.

1849. cephalus, Say. Topeka.
1854. pusillus, Sachse. Topeka.
—— An undetermined species. Lawrence.
—— One undescribed species. Topeka.

DIOCHUS, Er.

1864. Schaumii. Kr. Topeka.

LATHROBIUM, Grav.

1869. puncticolle, Kby. Lawrence.
1873. brevipenne, Lec. Topeka.
1879. longiusculum, Grav. Topeka and Lawrence.
—— Three undescribed species. Topeka.

CRYPTOBIUM, Mann.

1882. badium, Grav. Topeka.
1884. bicolor, Grav. Eastern Kansas.
1889. pallipes, Grav. Eastern Kansas.
1890. latebricola, Nordm. Topeka.

RUGILUS, Leach.

1896. angularis, Er. Topeka.
1897. dentatus, Say. Topeka.

SCOPÆUS, Er.

—— An undescribed species. Topeka.

LITHOCHARIS, Er.

1901. corticina, Grav. Topeka.
1902. confluens, Say. Topeka and Lawrence.
—— ochracea, Grav. Topeka.

SUNIUS. Steph.

1908. longiusculus, Mann. Topeka; abundant in the fall. winter and spring. under stones and boards.

PÆDERUS, Grav.

1914. littorarius, Grav. Eastern Kansas; common.

PINOPHILUS, Grav.

1921. opacus, Lec. Topeka; not common.

STENUS. Latr.

1927. colon, Say. Topeka; one specimen.
1932. stygicus, Say. Topeka.
1933. colonus, Er. Topeka.
1934. egenus, Er. Topeka; not rare in winter under stones.
1949. callosus, Er. Topeka.
—— N. sp. Topeka.

EUÆSTHETUS. Grav.

1951. americanus, Er. Topeka; one specimen.

OXYPORUS, F.

1957. rufipennis Lec. Topeka; rare.
1959. stygicus Say. Topeka; one specimen.

OSORIUS, Latr.

1963. latipes Grav. Topeka and Lawrence; frequent.

BLEDIUS, Leach.

1968. rubiginosus Er. Lawrence.
1976. annularis Lec. Topeka.

OXYTELUS, Grav.

1992. sculptus Grav. Topeka.
1993. insignitus Grav. Topeka.
—— An undetermined species. Topeka.

APOCELLUS, Er.

—— N. sp. Topeka.

TROGOPHLŒUS, Mann.

—— Two new species. Topeka.

ANTHOPHAGUS, Grav.

—— One undetermined species. Topeka.

OLOPHRUM, Er.

2023. rotundicolle Say. Topeka and Lawrence.

OMALIUM, Grav.

—— One undetermined species. Topeka.

GLYPTOMA, Er.

2078. costale Er. Topeka; one specimen.

PSELAPHIDÆ.

TMESIPHORUS. Lec.

2093. costalis Lec. Topeka; frequent under decayed logs.

CTENISTES, Reich.

2096. pulvereus Lec. Topeka.

BRYAXIS, Leach.

—— Several undetermined species. Topeka.

SILPHIDÆ.

SILPHA, Linn.

2176. marginata Fab. Eastern Kansas; common.
2181. pustulata Hersch. Topeka; a single specimen.
2183. americana Oliv. Eastern Kansas; frequent.
2184. orbicollis Say. Eastern Kansas; infrequent.
2185. tomentosa Web. Eastern Kansas; frequent.

PELTIS, Geoff.

2187. surinamensis Fab. Eastern Kansas; common.
2188. lapponica Hb. Lawrence.
2192. noveboracensis Forst. Eastern Kansas; common.
2193. inæqualis Fab. Eastern Kansas; common.
2194. truncata Say. Western Kansas.
2195. ramosa Say. "Fort Dodge and west." (Cooper.)
2196. americana L. Eastern Kansas; frequent.

CHOLEVA, Latr.

2206. opaca Say. Eastern Kansas; rare.

CATOPS, Payk.

2218. brunneipennis. Mann. Topeka; one specimen.

COLENIS, Er.

2246. impunctata Lec. Topeka; one specimen.

SCYDMÆNIDÆ.

SCYDMÆNUS, Latr.

—— An undetermined species; Topeka.

CORYLOPHIDÆ.

ORTHOPERUS. Steph.

2309. glaber Lec.

SACIUM, Lec.

—— An undetermined species; Topeka.

SCAPHIDIIDÆ.

SCAPHIDIUM, Oliv.

2325. quadriguttatum Say. Eastern Kansas.
2327. piceum Mels. Topeka; two specimens.

SCAPHISOMA, Leach.

2333. convexum Say. Topeka.
—— An undetermined species; Topeka.

TOXIDIUM, Lec.

2339. gammaroides Lec. Topeka; frequent.

LATRIDIIDÆ.

LATRIDIUS, Hb.

— An undetermined species is common at Topeka.

DERMESTIDÆ.

DERMETES, Linn.

2392. marmoratus Say. Throughout the State.
3393. Mannerheimii Lec. Topeka.
2394. fasciatus Lec. Lawrence.
2395. nubilus Say. Eastern Kansas.
2400. pulcher Lec. Eastern Kansas; rare.
2401. lardarius Linn. Eastern Kansas; introduced. Not common.
2403. bicolor Fab. Lawrence.
2404. maculatus Deg. Lawrence.

ATTAGENUS, Latr.

2406. megatoma Fab. Eastern Kansas; frequent.

TROGODERMA. Latr.

2418. tarsalis Mels. Eastern Kansas; frequent. This and the preceding are very destructive in collections of bird-skins or insects.

CRYPTORHOPALUM. Guer.

2424. picicorne Lec. Topeka.

ANTHRENUS, Geoff.

3428. thoracicus Mels. Topeka.
2430. varius Fab. Topeka.

ENDOMYCHIDÆ.

LYCOPERDINA, Latr.

2435. ferruginea Lec. Eastern Kansas.

MYCETINA. Muls.

3439. vittata Fab. Eastern Kansas.

ENDOMYCHUS, Hellw.

2451. biguttatus Say. Eastern Kansas.

ALEXIA. Steph.

3456. minor Cr. Topeka.

TRITOMIDÆ.

TRITOMA, Geoff.

2457. punctatus Say. Eastern Kansas; not common.
2458. flexuosus Say. Eastern Kansas; frequent.
2463. pluripunctatus Lec. Topeka; rare.

CRYPTOPHAGUS, Payk.

— An undetermined species. Topeka.

LITARGUS, Er.

2472. didesmus Say. Topeka; frequent.

TYPHŒA. Curt.

2474. fumata L. Lawrence.

CIOIDÆ.

CIS, Latr.

— Three undetermined species, taken at Topeka.

EROTYLIDÆ.

LANGURIA, Latr.

2505. bicolor Fab. Eastern Kansas. Var. puncticollis Say, is common on Cacalia tuberosa.
2506. Mozardi Latr. Eastern Kansas; not rare.
2509. angustata Bv. Lawrence.
2509a. trifasciata Say. Eastern Kansas; found under stones in early spring; rare.
2512. Lecontei Crotch. Eastern Kansas; rare.

DACNE, Latr.

2515. quadrimaculata Say. Topeka; one specimen.

HYPODACNE, Lec.

— punctata, Lec. Topeka and Lawrence.

MEGALODACNE, Cr.

2517. fasciata Fab. Lawrence.

ISCHYRUS, Lac.

2520. quadripunctatus Oliv. Eastern Kansas.

MYCOTRETUS, Lac.

2524. pulchra Say. Topeka; taken from under walnut bark; rare.

CYRTOTRIPLAX, Cr.

2530. atriventris Lec. Topeka; three specimens.
2532. unicolor Say. Eastern Kansas; common.

TRIPLAX, Hb.

2537. thoracica Say. Eastern Kansas; common.
2540. flavicollis Lec. Topeka; one specimen.

ATOMARIIDÆ.

TOMARUS, Lec.

2562. pulchellus Lec. Topeka.

ATOMARIA, Steph.

2573. ephippiata Zimm. Topeka; common.

EPHISTEMUS, Steph.

2574. apicalis Lec. Topeka.

LOBERUS, Lec.

2576. impressus Lec. Topeka.

SILVANUS, Latr.

2579. advena Waltl. Topeka.
2580. surinamensis, Linn. Topeka; common; infesting mills and granaries.
2582. planatus Germ. Topeka; under bark.

CUCUJIDÆ.

CATOGENUS, Westw.

2592. rufus Fab. Eastern Kansas.

CUCUJUS, Fab.

2594. clavipes Fab. Eastern Kansas.

LÆMOPHLÆUS, Lap.

2598. biguttatus Say. Lawrence.

ULIOTA, Latr.

2610. dubia Fab. Eastern Kansas; freqcent.

BITOMIDÆ.

BITOMA, Hb.

2614. striatus Mels. Eastern Kansas.

TROGOXYLON, Lec.

2618. parallelopipedum Mels. Lawrence.

COLYDIIDÆ.

SYNCHYTODES, Cr.

2626. quadriguttata Say. Topeka.

EUDESMA, Lec.

2627. undulata Mels. Topeka.

SYNCHITA, Hellw.

2628. granulata Say. Topeka.
2629. nigripennis Lec. Lawrence.

CICONES, Curt.

2633. marginalis Mels. Topeka.

COLYDIUM, Fabr.

2642. lineola Say. Topeka.

BOTHRIDERES, Er.

2646. geminatus Say. Topeka.

PHILOTHERMUS, Aube.

2652. glabriculus Lec. Topeka.

CERYLON, Latr.

2654. castaneum Say. Topeka.

RHYSSODIDÆ.

RHYSSODES, Dalm.

3657. exaratus Ill. Eastern Kansas.

RHIZOPHAGIDÆ.

RHIZOPHAGUS, Hb.

2663. bipunctatus Say. Topeka; two specimens.

HESPEROBÆNUS, Lec.

2670. rufipes Lec. Lawrence.

MONOTOMA, Hb.

2673. fulvipes Mels. Lawrence.

TROGOSITIDÆ.

ALYNDRIA, Er.

2684. cylindrica Serv. Tonganoxie, Lawrence, Topeka.

TENEBRIOIDES, Pall.

2686. mauritanica L. Topeka.
2688. corticalis Mels. Eastern Kansas.
2693. castanea Mels. Topeka; a single specimen, taken under bark.
2693a. laticollis Horn. Topeka and Lawrence.
2693b. obscura Horn. Topeka.

NITIDULIDÆ.

TRIXAGUS, Kug.

2705. unicolor Say. Topeka; taken on flowers of Cornus.

CERCUS, Latr.

2710. abdominalis Er. Topeka and Lawrence.

CARPOPHILUS, Steph.

2726. hemipterus Linn. Topeka.
2728. rufus Murr. Western Kansas.

EPURÆA, Er.

2752. rufa Say. Eastern Kansas; an undetermined species; Lawrence.

NITIDULA, Fabr.

2753. bipustulata L. Eastern Kansas; common.
2754. rufipes L. Lawrence.
2755. ziczac Say. Throughout Kansas, varying greatly in size; common.

PROMETOPIA, Er.

2756. sexmaculata Say. Eastern Kansas.

OMOSITA, Er.

2760. colon L. Eastern Kansas; common.

PHENOLIA, Er.

2762. grossa Fab. Eastern Kansas. Found in fungi and in decayed wood; frequent.

MELIGETHES, Steph.

2766. sævus Lec.

PALLODES, Er.

2783. silaceus Er. Topeka; in fungi.

CRYPTARCHA, Shuck.

2785. ampla Er. Lawrence.

PITYOPHAGUS, Shuck.

2788. quadriguttatus Fab. Eastern Kansas, common.

PHALACRIDÆ.

PHALACRUS, Payk.

2806. politus Mels. Topeka; frequent.

OLIBRUS, Er.

2817. consimilis Msh. Topeka; common.
2819. nitidus Mels. Topeka; very abundant throughout the year.
—— One undetermined species; Topeka.

COCCINELLIDÆ.

EPILACHNA, Redt.

—— borealis Fab. Lawrence.

MEGILLA, Muls.

2823. maculata DeG. Eastern Kansas; occurs in great numbers. The most abundantly represented species of the family in this section.

HIPPODAMIA, Chev.

2830. glacialis Fab. Throughout the State; common, and varies much in the black elytral markings. A specimen in my cabinet has the markings united into a broad, black triangle, with a small central red dot. Others have three small black dots disposed in a triangle.
2832. convergens Guer. Common throughout Kansas. The most abundant coccinellid in Western Kansas, where it occurs on Helianthus and other coarse, strong-scented herbs. Specimens with immaculate elytra are frequent.
2836. tridecimpunctata L. Eastern Kansas; not common.
2837. parenthesis Say. Eastern and Western Kansas; infrequent at Topeka.

COCCINELLA, Linn.

2847. novemnotata Hb. Eastern Kansas; common.
2848. quinquenotata Kby. Western Kansas.

CYCLONEDA, Cr.

2853. sanguinea L. Eastern and middle Kansas; very abundant.
2854. oculata Fab. Topeka; frequent.
2854a. abdominalis Say. Eastern and middle Kansas; occurs with the last in about the same numbers.

ADALIA, Muls.

2856. bipunctata Linn. Lawrence.

ANATIS, Muls.

2862. quindecimpunctata Oliv. Eastern Kansas.

CHILOCORUS, Leach.

2869. bivulnerus Muls. Eastern Kansas; frequent.

EXOCHOMUS, Redt.

—— tripustulatus DeG. Topeka.

ŒNEIS, Muls.

2874. pusilla Lec. Topeka. ((

BRACHYACANTHA, Muls.

2876. dentipes Fab. Eastern Kansas; common.
2877. ursina F. Eastern Kansas; frequent.
2877c. basalis Mels. Lawrence.

HYPERASPIS, Chev.

2882. fimbriolata Mels. Topeka; Rooks county.
2889. proba Say. Lawrence.
2892. lugubris Rand. Topeka.
2894. undulata Say. Topeka.
2896. annexa Lec. Western Kansas.

SCYMNUS, Kug.

2904. flavifrons Mels. Lawrence.
2919. hæmorrhous Lec. Topeka.
2920. caudalis Lec. Topeka.
—— Three undetermined species. Topeka.

PARNIDÆ.

HELICHUS, Er.

2975. lithophilus Germ. Lawrence.

2976. fastigiatus Say. Topeka.
2977. striatus Lec. Topeka; rare.

HETEROCERIDÆ.

HETEROCERUS, Fab.

3014. limbatus Kies.
3016. pallidus Say. Topeka and Rooks county.
—— Three other species.

HISTERIDÆ.

HOLOLEPTA, Payk.

3023. fossularis Say. Eastern Kansas; frequent.

HISTER, L.

3032. biplagiatus Lec. Eastern Kansas; frequent.
3033. Ulkei Horn. Western Kansas.
3037. Harrisii Kby. Eastern Kansas.
3039. interruptus Bv. Var. Topeka.
3049. abbreviatus Fab. Topeka; frequent.
3053. depurator Say. Eastern Kansas; frequent.
3056. incertus Mars. Topeka.
3059. defectus Lec. Topeka.
3063. sedecimstriatus Say. Eastern Kansas; common.
3065. americanus Payk. Eastern Kansas; common.
3068. nubilus Lec. Topeka.
3069. pollutus Lec. Lawrence.
3073. subrotundus Say. Topeka and Rooks county; common.
3074. vernus Say. Topeka.
3076. carolinus Payk. Eastern Kansas; under elm bark; common.
3077. Lecontei Mars. Lawrence and Topeka.

EPIERUS, Er.

3090. pulicarius, Er. Topeka.

TRIBALUS, Er.

3094. americanus Lec. Topeka.

PAROMALUS, Er.

3103. estriatus Lec. Topeka.
3104. conjunctus Say. Topeka.
3107. 14-striatus Steph. Topeka.
3114. bistriatus Er. Topeka.

DENDROPHILUS, Leach.

3116. punctulatus Say. Topeka and Lawrence.

SAPRINUS, Leach.

3119. rotundatus Kug. Lawrence and Topeka.
3131. lugens Er. Topeka and western Kansas.
3133. pennsylvanicus Pk. Throughout Kansas; common. Western specimens seem to have the metallic hues brightest.
3138. assimilis Payk. Throughout Kansas.
3141. placidus Er. Topeka.

BACANIUS, Lec.

3186. misellus Lec. Topeka.

LUCANIDÆ.

LUCANUS, L.

3202. elaphus F. Lawrence.
3203. dama Thunb. Eastern Kansas; common.
3204. placidus Say. Eastern Kansas; common.

DORCUS, McL.

3207. parallelus Say. Topeka and Lawrence; rare.

PLATYCERUS, Geoff.

3208. quercus Web. Eastern Kansas.

CERUCHUS, McL.

3213. piceus Web. Eastern Kansas.

PASSALUS, Fab.

3216. cornutus Fab. Eastern Kansas; frequent.

SCARABÆIDÆ.

CANTHON, Hoff.

3228. viridis Bv. Topeka; rare.
3230. hudsonias Forst. Throughout Kansas; abundant at Topeka.

CHŒRIDIUM, Lep.

3233. histeroides Web. Eastern Kansas.

COPRIS, Geoff.

3234. carolina Linn. Eastern Kansas; rare.
3237. anaglypticus Say. Eastern Kansas; common.
3238. minutus Dru. Eastern Kansas; common.

PHANÆUS, McL.

3241. carnifex Linn. Eastern Kansas; abundant.
3242. triangularis Say. Lawrence; rare. Specimens sent me by Mr. G. F. Gaumer.

ONTHOPHAGUS, Latr.

3244. latebrosus Fab. Eastern and middle Kansas; common.
8126. pennsylvanicus Hn. Eastern Kansas.

APHODIUS, Ill.

3259. fimetarius L. Eastern Kansas; frequent.
3268. granarius L. Topeka and Lawrence.
3274. serval Say. Lawrence.
3275. inquinatus Hb. Topeka; frequent.
3282. rubeolus Bv. Topeka; rare.
3283. stercorosus Mels. Eastern Kansas.
3291. concavus Say. Eastern Kansas; infrequent.
3293. alternatus Hn. Lawrence.
3296. bicolor Say. Eastern Kansas.
3299. femoralis Say. Eastern Kansas; abundant.
3302. oblongus Say. Topeka.

ATÆNIUS, Harr.

3309. robustus Horn. Topeka; rare.
3311. gracilis Mels. Topeka; one specimen.
3313. stercorator Fab. Eastern Kansas.
3319. abditus Hald. Lawrence.

RHYSSEMUS, Muls.

—— new species. Topeka; found in pools left after rain.

BOLBOCERAS, Kby.

3351. farctus Fab. Eastern Kansas; frequent.
3352. lazarus Fab. Eastern Kansas; common.

ODONTÆUS, Klug.

3353. filicornis Say. Eastern Kansas; rare.

GEOTRYPES, Latr.

3357. splendidus Fab. Eastern Kansas; common.
3359. Egeriei Germ. Eastern Kansas; common.
3360. opacus Hald. Eastern Kansas; infrequent.

CLŒOTUS, Germ.

3367. aphodioides Ill. Eastern Kansas; frequent.

TROX, Fab.

3375. pustulatus Lec. Eastern Kansas.

3377. suberosus Fab. Lawrence and Topeka.
3378. morsus Lec. Lawrence.
3379. punctatus Germ. Eastern and western Kansas; common.
3381. Sonoræ. Topeka; common.
3383. porcatus Say. Lawrence.
3384. tuberculatus DeG. Eastern Kansas.
3386. foveicollis Harold. Lawrence.
3387. terrestris Say. Topeka.
3388. capillaris Say. Topeka; frequent.
3390. æqualis Say. Eastern Kansas.
3394. atrox Lec. Topeka; two specimens.

SERICA, McL.

3429. vespertina Sch. Eastern Kansas.
3436. sericea Ill. Eastern Kansas.

MACRODACTYLUS, Latr.

3445. subspinosus F. (?) Topeka.

DIPLOTAXIS, Kby.

3469. frondicola Say. Eastern Kansas; common.

PHYLLOPHAGA, Harris.

3502. congrua Lec. Topeka and Lawrence.
3503. futilis Lec. Lawrence.
3504. fusca Frohl. Eastern Kansas.
3504d. puncticollis Bl. Eastern Kansas.
3504e. Drakii Kby. Lawrence.
—— micans Lec. Lawrence.
3512. cognata Burm. Lawrence.
3513. fraterna Harr. Lawrence.
3516. calceata Lec. Lawrence.
3517. marginalis Lec. Lawrence.
3518. crassissima Bl. Rooks county.
3520. rugosa Mels. Lawrence.
3523. ilicis Kn. Lawrence.
3527. hirticula Kn. Eastern Kansas.
3528. hirsuta Kn. Lawrence.
3540. crenulata Frohl. Eastern Kansas.
3543. rubiginosa Lec. Lawrence.
3547. tristis Fab. Eastern Kansas; common.

TOSTEGOPTERA, Bl.

3564. anceolata Say. Rare at Topeka, but very common in the middle and western Kansas.

MACRANOXIA, Cr.

3566. Hammondi Lec. Rare at Topeka; common in middle Kansas.

ANOMALA, Kæppe.

3577. varians Fab. Eastern Kansas; common.
3578. minuta Burm. Eastern Kansas; less common than the last.
3581. binotata Gyll. Topeka and western Kansas; frequent.
3584. marginata Fab. Eastern Kansas.

STRIGODERMA, Bm.

3588. arboricola Fab. Western Kansas; quite rare at Topeka.

PELIDNOTA, McL.

3589. punctata L. Eastern Kansas; common.

COTALPA, Bm.

3593. lanigera L. Eastern Kansas; not common.
3596. ursina Hn. "Topeka, (?) but without doubt from Kansas." (Cooper.)

CYCLOCEPHALA, Latr.

3597. immaculata Burm. Eastern Kansas; very abundant.

CHALEPUS, McL.

3607. trachypygus Bm. Eastern Kansas; rare.
—— Another species, "more strongly punctured than obsoletus" (Lec.), size of Ligyrus relictus (Say.) Dodge City.

LIGYRUS, Bm.

3609. gibbosus DeG. Throughout Kansas; very abundant at Topeka, burrowing at the roots of the cocklebur (Xanthium).
3612. relictus Say. Eastern Kansas; common about manure piles.

POLYMŒCHUS, Lec.

3620. brevipes Lec. Lawrence.

XYLORYCTES, Hope.

3621. satyrus Fab. Topeka and Lawrence.

STRATEGUS, Hope.

3622. antæus, Fab. "Topeka." (Cooper.)

DYNASTES, Kby.

3627. tityus Linn. "Smoky Hill river." (Cooper.)

PHILEURUS, Latr.

3631. valgus F. Eastern Kansas.

ALLORHINA, Bm.

3635. nitida L. Neodesha. (Snow.)

EURYOMIA, Bm.

3639. melancholica Gory. Eastern Kansas; abundant; often found gouging ripe fruit in company with E. inda, and other beetles.
3640. sepulchralis Fab. Lawrence.
3645. Kernii Hald. Western Kansas; common. A black variety, less common than the species, is found with it in flowers of Cirsium and Argemone.
3646. inda L. Eastern Kansas; abundant.
3650. fulgida F. Eastern Kansas; frequent; found on Asclepias cornuti.
3651. areata Fab. Extreme western Kansas; found on thistle-heads.

CREMASTOCHILUS, Kn.

3659. Knochii Lec. Eastern Kansas; frequent.

OSMODERMA, Lep.

3665. eremicola Kn. Eastern and middle Kansas; infrequent.

TRICHIUS, Fab.

3672. affinis Gory. Eastern Kansas; common.

VALGUS, Scriba.

3674. canaliculatus F. Eastern Kansas; in rotten wood and under logs.

BUPRESTIDÆ.

CHALCOPHORA, Sol.

3683. virginiensis Dru. "Topeka." (Cooper.)
3684. liberta Germ. "Topeka." (Cooper.)
3687. campestris Say. Lawrence.

PSILOPTERA, Sol.

3688. Drummondi Lap. "Dodge City, and westward to Pueblo, Col." (Cooper.)

DICERCA, Esch.

3692. obscura Fab.(?) Lawrence.
3692a. lurida Fab. Topeka and Lawrence.

PŒCILONOTA, Esch.

3707. cyanipes Say. Two specimens sent me from Tonganoxie, collected there by Mr. Ashton.
3708. ferrea Mels. Lawrence.

BUPRESTIS, Linn.

3711. rufipes Oliv. Eastern and middle Kansas; rare.
3713. confluens Say. A few specimens

taken by me at Stockton, Rooks county, on a cottonwood log.
3719a. Langii Mann. "Topeka." (Cooper.)

CINYRA, Lap.

3737. gracilipes Mels. Lawrence.

MELANOPHILA, Esch.

3732. longipes Say. "Very abundant on Smoky Hill river in August." (Cooper.)

ANTHAXIA, Esch.

3740. viridicornis Say. Lawrence.
3741. viridifrons Gory. Lawrence.

CHRYSOBOTHRIS, Esch.

3747. femorata Lec. Eastern Kansas; very abundant, and is the parent beetle of the destructive "flat-headed borer."
3747c. Lesueruri Gory. Western Kansas.
3764. sexsignata Say. Lawrence.
3767. azurea Lec. var. Lawrence.

ACMÆODERA, Esch.

3791. pulchella Hb. Lawrence.
3791b. mixta Lec. Eastern Kansas; common, and found on heads of Lepachys.
3795. culta Web. Eastern Kansas; common.

PTOSIMA, Sol.

3799. gibbicollis Say. Eastern Kansas; not common.

AGRILUS, Sol.

3808. fulgens Lec. Lawrence.
3809. otiosus Say. Lawrence.
3809b. defectus Lec. Lawrence and Topeka.
3810. difficilis Gory. Lawrence.
3812. bilineatus Weber. Topeka.
3815. fallax Say. Lawrence.
3816. interruptus Lec. Lawrence.
3821. acutipennis Mann. Topeka.
3825. politus Say. Lawrence.

BRACHYS, Sol.

3839. tesselata Fab. A single specimen taken by me at Topeka.
3841. ærosa Mels. Topeka; three specimens.
3842. æruginosa Gory. Lawrence.

THROSCIDÆ.

DRAPETES, Redt.

3855. geminatus Say. Topeka; one specimen.
3856. quadripustulatus Bonv. Topeka.

ELATERIDÆ.

STETHON, Lec.

3865. pectorosus Lec. Lawrence and Topeka.

DELTOMETOPUS, Bv.

3866. amænicornis Say. Lawrence.

FORNAX, Lep.

3874. badius Mels. Lawrence and Topeka.

ADELOCERA, Latr.

3914. impressicollis Say. Lawrence.
3915. discoidea Web. Eastern Kansas; frequent.
3920. marmorata Fab. Lawrence.

LACON, Germ.

3925. rectangularis Say. Throughout Kansas.

ALAUS, Esch.

3932. gorgops Lec. Lawrence.
3933. oculatus L. Eastern and middle Kansas.

CARDIOPHORUS, Esch.

3938. amictus Mels. Eastern Kansas.

CRYPTOHYPNUS, Esch.

3995. pectoralis Say. Topeka; abundant.

ELATER, L.

4005. linteus Say. Lawrence.
4024. manipularis Cand. Lawrence.

DRASTERIUS, Esch.

4050. dorsalis Say. Eastern Kansas; common.

MONOCREPIDIUS, Esch.

4080. lividus Deg. Eastern Kansas.
4086. vespertinus Fab. Eastern Kansas; abundant.
4090. auritus Hb. Eastern Kansas; common at Topeka.

LUDIUS, Latr.

4104. attenuatus Say. Eastern Kansas.

ORTHOSTETHUS, Lac.

4106. infuscatus Germ. Lawrence.

CRIGMUS, Lec.

4107. hepaticus Germ. Lawrence and Topeka.

AGRIOTES, Esch.

4113. sordidus Lec. Topeka.

GLYPHONYX, Cand.

4125. recticollis Say. Lawrence.
4126. testaceus Mels. Topeka.

MELANOTUS, Esch.

4131. macer Lec. Lawrence and Topeka.
4133. incertus Lec. Lawrence.
4141. angustatus Er. Topeka; occasional.
4145. scrobicollis Lec. Topeka.
4149. fissilis Say. Lawrence.
4150. communis Gyll. Lawrence and Topeka.
4151. exuberans Lec. Topeka.
4156. infaustus Lec. Lawrence.
4157. cribulosus Lec. Lawrence.
4160. pertinax Say. Lawrence.
4161. dubius Lec. Topeka.
4163. americanus Hb. Topeka.
4167. opacicollis Lec. Topeka.
4170. morosus Cand. Lawrence.
—— An undescribed species. Topeka.

LIMONIUS, Esch.

4177. pubicollis Lec. Lawrence.
4186. griseus Bv. Eastern Kansas; frequent.
4208. ectypus Say. Topeka.

ATHOUS, Esch.

4226. cucullatus Say. Topeka.

CORYMBITES, Latr.

4326. inflatus Say. Topeka; infrequent.

SERICOSOMUS, Esch.

—— pauper. Topeka.

ASAPHES, Kby.

4337. memnonius Hb. Eastern Kansas.
4339. æreus Mels. Lawrence.

MELANACTES, Lec.

4352. piceus DeG. Topeka and Lawrence.
4354. morio Fab. Topeka and Lawrence.
4355. puncticollis Lec. Topeka and Lawrence.

RHIPICERIDÆ.

ZENOA, Say.

4371. picea Bv. Lawrence, Topeka and Tonganoxie. (Mr. Ashton.)

SANDALUS, Kn.

4372. niger Kn. Lawrence.

4374. petrophya Kn. Lawrence and Topeka.

DASCYLLIDÆ.

CYPHON, Fab.

4391. punctatus Lec. Topeka.
4399. ruficollis Say. Topeka.

PTILODACTYLA, Latr.

4417. serricollis Say. Lawrence.

LAMPYRIDÆ.

LYCUS, Fabr.

4420. lateralis Mels.

CALOPTERON, Guer.

4422. typicum Newm. Lawrence.
4423. reticulatum Fab. Topeka and Lawrence.

EROS, Newm.

4430. coccinatus Say. Topeka; not common.
4437. humeralis F. Topeka and Lawrence.
4438. trilineatus Mels. Topeka and Lawrence.
4439. modestus Say. Topeka.

LUCIDOTA, Lap.

4446. atra Fab. Eastern Kansas.

PHOTINUS, Lap.

4457. angulatus Say. Topeka; frequent.
4459. angustatus Lec. Topeka; frequent.
4465. pyralis Linn. Eastern Kansas; Rooks county.
4467. scintillans Say. Topeka; frequent.

PHOTURIS, Lec.

4471. pennsylvanica DeG. Eastern Kansas; Rooks county; common.
4473. divisa Lec. Topeka; common.

PHENGODES, Hoffm.

4474. plumosa Oliv. Eastern Kansas.

TELEPHORIDÆ.

CHAULIOGNATHUS, Hentz.

4477. americanus Forst. Eastern Kansas; very common.
4481. basalis Lec. Western Kansas.
4484. marginatus Fab. Eastern Kansas.

PODABRUS, Westw.

4488. flavicollis Lec. Topeka.
4491. modestus Say. Eastern Kansas.
4498. tomentosus Say. Lawrence.
4499. rugosulus Lec. Eastern Kansas.

TELEPHORUS, Schæffer.

4519. excavatus Lec. Lawrence.
4520. carolinus Fab. Eastern Kansas.
4524. imbecillus Lec. Lawrence.
4526. flavipes Lec. Topeka; common.
4547. collaris Lec. Topeka and Lawrence.
4548. bilineatus Say. Eastern Kansas.
4550. divisa Lec. Lawrence.
4553. laticornis Say. Lawrence.

TRYPHERUS, Lec.

4562. latipennis Germ. Lawrence and Topeka; frequent.

MALACHIIDÆ.

COLLOPS, Er.

4576. tricolor Say. Lawrence.
4577. punctatus Lec. Topeka; one specimen.
4582. bipunctatus Say. Western Kansas.
4584. quadrimaculatus F. Eastern Kansas; common.

ANTHOCOMUS, Er.

—— An undetermined species. Lawrence.

ATTALUS, Er.

4630. melanopterus Er. Topeka.
4636. otiosus Say. Topeka.
4641. scincetus Say. Topeka; common in early spring.

LISTRUS, Motsch.

—— One undetermined species. Topeka.

CLERIDÆ.

CYMATODERA, Gray.

4703. inornata Say. Eastern Kansas.
4705. undulata Say. Eastern and western Kansas.

THANASIMUS, Latr.

4725. nigripes Say. Eastern Kansas.
4727. rosmarus Say. Eastern Kansas.
4728. lunatus Spin. Lawrence.
4731. abruptus Lec. "Smoky Hill River" (Cooper).
4740. thoracicus Ol. Lawrence.

HYDNOCERA, Newm.

4750. unifasciata Say. Rooks county.
4754. humeralis Say. Eastern Kansas; frequent.
4754b. difficilis Lec. Lawrence.
4759. pallipennis Say. Topeka and Lawrence.

CHARIESSA, Perty.

4775. pilosa Forst. Topeka and Lawrence.
4775a. onusta Say. Topeka.

CREGYA, Lec.

4776. vetusta Spin. Lawrence and Topeka.

ORTHOPLEURA, Spin.

4781. damicornis Fab. Lawrence.

CORYNETES, Hb.

4791. violaceus L. Eastern Kansas.

CUPESIDÆ.

CUPES, Fab.

4798. concolor Westw. Lawrence.

PTINIDÆ.

PTINUS, L.

4804. fur L. Eastern Kansas; infests museums; destroys entomological and botanical specimens.
4807. quadrimaculatus Mels. Lawrence.
4808. bimaculatus Mels. (?) Topeka.

TRICHODESMA, Lec.

4827. gibbosa Say. Tonganoxie and Wakarusa; rare.

HADROBREGMUS, Thoms.

4830. carinatus Say. Topeka.

XYLETINUS, Latr.

4844. peltatus Harr. Lawrence.

PROTHECA, Lec.

4859. puberula Lec. Topeka; three specimens.

PTILINUS, Geoff.

4866. ruficornis Say. Topeka.

ENDECATOMUS, Mell.

4870. rugosus Rand. Lawrence.

SINOXYLON, Duf.

4875. basilare Say. Topeka; rare.

BOSTRYCHUS, Geoff.

4877. bicornis Web. Eastern Kansas; infrequent.

AMPHICERUS, Lec.

4880. bicaudatus Say. Eastern Kansas; abundant and troublesome in vineyards, boring in the twigs.

DINODERUS, Steph.

4883. punctatus Say. Eastern Kansas.

SPONDYLIDÆ.

PARANDRA, Latr.

4898. brunnea Fab. Eastern Kansas.

CERAMBYCIDÆ.

ORTHOSOMA, Serv.

4915. brunneum Forst. Eastern Kansas.

PRIONUS, Geoff.

4916. laticollis Dru. Lawrence.
4919. imbricornis L. Eastern Kansas.

HOMÆSTHESIS, Lec.

4922. integer Lec. (Snow.).

SMODICUM, Lec.

4941. cucujiforme Say. Eastern Kansas.

DULARIUS, Thoms.

4943. brevilineus Say. Lawrence.

HYLOTRUPES, Serv.

4947. ligneus Fab. Imported in cedar posts. (Cooper.)

PHYMATODES, Muls.

4952. varius Fab. Lawrence.
4954. amænus Say. Lawrence and Topeka.

CHION, Newm.

4987. cinctus Dru. Eastern Kansas.

EBURIA, Serv.

4991. quadrigeminata Say. Eastern Kansas.

ELAPHIDION, Serv.

4999. simplicicolle Hald. Eastern Kansas.
5000. atomarium Dru. Eastern Kansas.
5005. mucronatum F. Eastern Kansas.
5006. incertum Newm. Lawrence and Topeka.
5010. villosum Fab. Eastern Kansas.
5011. parallelum Newm. Lawrence and Topeka.
5017. cinerascens Lec. Lawrence.

HETERACHTHES, Newm.

5030. quadrimaculatus Newm. Lawrence.
5031. ebenus Newm. Lawrence and Topeka.

CALLIMOXYS, Kr.

5044. sanguinicollis, Oliv. Topeka.

MOLORCHUS, F.

5047. bimaculatus Say. Topeka.

RHOPALOPHORA, Serv.

5051. longipes Say. Eastern Kansas.

TRAGIDION, Serv.

5067. annulatum Lec. "Topeka." (Cooper.)
5068. coquus Fab. Eastern Kansas; rare.
5068a. fulvipennis Say. Eastern Kansas; more common than coquus; taken gouging ripe fruit, watermelons, peaches. etc.

PURPURICENUS, Serv.

5070. humeralis Say. Eastern Kansas; frequent.

BATYLE, Thoms.

5077. ignicollis Say. Eastern, middle and western Kansas; not common.
5079. suturalis Say. Throughout the State.
5081. Pearsalli, Bland. Middle and western Kansas.

TYLOSIS, Lec.

5085. maculata Lec. Lawrence.

STENOSPHENUS, Hald.

5098. notatus Oliv. Lawrence.

CYLLENE, Newm.

5102. pictus Dru. Eastern Kansas.
5103. robiniæ Forst. Eastern Kansas.
5106. charus Say. Eastern Kansas; common on golden-rod (Solidago rigida), and varies much in its markings.

GLYCOBIUS, Lec.

5120. speciosus Say. Topeka and Lawrence; but two specimens taken.

CALLOIDES, Lec.

5111. nobilis Say. Lawrence and Topeka. "Lives in oak wood." (Cooper.)

ARHOPALUS, Serv.

5113. fulminans Fab. Eastern and middle Kansas.

XYLOTRECHUS, Chev.

5116. colonus Fab. Eastern and middle Kansas; frequent.

NEOCLYTUS, Thoms.

5131. luscus F. Lawrence.
5133. capræa Say. Topeka and Lawrence.
5135. erythrocephalus Fab. Eastern Kansas.

EUDERCES, Lec.

5147. picipes Fab. Eastern Kansas; common on flowers of Cornus paniculata.

DISTENIA, Serv.

5155. undata Oliv. Eastern Kansas.

DESMOCERUS, Serv.

5156. palliatus Forst. Eastern Kansas.

TOXOTUS, Serv.

5177. cinnamopterus Rand. Eastern Kansas, on dogwood blossoms.

STRANGALIA, Serv.

5215. luteicornis F. Lawrence and Topeka.

TYPOCERUS, Lec.

5221. velutinus Oliv. Lawrence.
5224. sinuatus Newm. Rare at Topeka, but very abundant in middle and western Kansas, and varies much in coloration.

LEPTURA, Serv.

5225. emarginata F. A single specimen, taken at Topeka, by me.
5226. gigas Lec. "Smoky Hill river." (Cooper.)
5257a. convexa Lec. Western Kansas.
5280. proxima Say. "Smoky Hill river." (Cooper.) "Western Kansas." (Snow.)

MONILEMA, Say.

5306. annulatum Say. Western Kansas; common; lives on Opuntia or prickly pear. A larva, probably of this species, was taken at Granada, Col., from the stem of an Opuntia.

PSENOCERUS, Lec.

5318. supernotatus Say. Lawrence and Topeka.

MONOHAMMUS, Serv.

5323. scutellatus Sap. "Near Tecumseh, Shawnee county." (Cooper.)

DORCASCHEMA, Lec.

5328. Wildii Uhler. Eastern Kansas; rare.
5329. alternatum Say. Eastern Kansas.
5330. nigrum Say. Eastern Kansas; rare.

HETŒMIS, Hald.

5331. cinerea Oliv. Lawrence and Topeka.

PLECTRODERA, Lec.

5339. scalator F. Eastern and middle Kansas; rare. Lives in willow. (Brous.)

ACANTHODERES, Serv.

5342. decipiens Hald. Lawrence.

LEPTOSTYLUS, Lec.

5347. aculifer Say. Eastern Kansas.
5355. macula Say. Eastern Kansas.

STERNIDIUS, Lec.

5356. variegatus Hald. Lawrence.
5357. alpha Say. Eastern Kansas.
5358. cinereus Lec. Lawrence.

LIOPUS, Serv.

5363. signatus Lec. Lawrence.
5365. querci Fitch. Layrence.

LEPTURGES, Bates.

5368. angulatus Lec. Eastern Kansas.

GRAPHISURUS, Kby.

5374. fasciatus DeG. Eastern Kansas.

DECTES, Lec.

5381. spinosus Say. Eastern Kansas.

ECYRUS, Lec.

5392. exiguus Lec. Lawrence.

ONCIDERES, Serv.

5403. cingulatus Say. Lawrence.

ATAXIA, Hald.

5404. crypta Say. Lawrence.

HIPPOPSIS, Serv.

5405. lemniscata Fab. Eastern Kansas.

SAPERDA, Fab.

5409. obliqua Say. "Topeka." (Cooper.)
5410. calcarata Say. Topeka and Lawrence.
5412. candida Fab. Eastern Kansas.
5415. vestita Say. "Topeka." (Cooper.)
5416. discoidea Fab. Eastern Kansas.
5417. tridentata Oliv. Eastern Kansas.
5418. lateralis Fab. Eastern Kansas.

MECAS, Lec.

5424. inornata Say. Middle and western Kansas.
5425. pergrata Say. "Topeka." (Cooper.)
5426. gentilis Lec. Lawrence.

OBEREA, Muls.

5431. amabilis Hald. Topeka and Lawrence.
5433. tripunctata F. Lawrence.
5436. oculaticollis Say. Western Kansas.

TETROPS, Steph.

5440. canescens Lec. "Western Kansas." (Cooper.)

TETRAOPES, Serv.

5445. tetraopthalmus Forst. Eastern Kansas; very common.
5447. quinquemaculatus Hald. Topeka; frequent.
5448. femoralis Lec. Western Kansas. (Cooper.)

AMPHIONYCHA, Thoms.

5453. flammata Newm. Lawrence.
5454. ardens Lec. Topeka and Lawrence; also, in middle Kansas. Found on the stems of Vernonia.

SPERMOPHAGIDÆ.

SPERMOPHAGUS, Sch.

5459. Robiniæ Sch. Tonganoxie, Topeka and Lawrence; rare.

BRUCHUS, L.

5463. pisi L. Eastern Kansas.
5464. mimus Say. Lawrence and Topeka.
5472. discoideus Say. Topeka.
5476. bivulneratus Horn. Topeka; one specimen.
5477. cruentatus Horn. Topeka; common.
5491. bisignatus Horn. Topeka.
5497. amicus Horn. Topeka.
5498. obsoletus Say. Lawrence and Topeka.
5499. hibisci Oliv. Topeka.
5506. seminulum Horn. Topeka; frequent.

CHRYSOMELIDÆ.

DONACIA, F.

5521. subtilis Kunze. Lawrence.

MACROPLEA, Sam.

5533. Melsheimeri Lac. Lawrence.

ZEUGOPHORA, Kunze.

5537. scutellaris Suffr. Topeka; one specimen.

LEMA, Fabr.

5550. collaris Say. Topeka; common on Tradescantia virginica in spring.
5554. trilineata Oliv. Eastern Kansas; common on Physalis; more rarely found on Irish potatoes.

ANOMŒA, Lac.

5559. laticlavia Forst. Eastern Kansas; common. Found on Vernonia.

BABIA, Chev.

5561. quadriguttatæ Oliv. Eastern and middle Kansas; found on Rhus glabra.

SAXINIS, Lac.

5563. omogera Lac. Topeka; one specimen.
5564. Saucia Lec. Western Kansas.

COSCINOPTERA, Lac.

5569. axillaris Cr. Rooks county; two specimens.
5571. dominicana Fab. Eastern and middle Kansas; abundant on Rhus glabra.

CHLAMYS, Kn.

5575b. polycocca Lac. Eastern Kansas; frequent.

MONACHUS, Chev.

5579. saponatus Fab. Topeka and Lawrence.

CRYPTOCEPHALUS, Geoff.

5583. congestus Fab. Lawrence.
5590. flaccidus Suffr. Lawrence.
5596. ornatus Fab. Eastern Kansas.
5603. dispersus Hald. Eastern and middle Kansas.
5606. leucomelas Suffr. Eastern Kansas.
5608. mucoreus Lec. Eastern and middle Kansas; abundant on Rhus glabra.
5612. quadruplex Newm. Eastern and middle Kansas; abundant on Rhus glabra.

GRIBURIUS, Hald.

5624. scutellaris Fab. Eastern Kansas.

PACHYBRACHYS, Chev.

5631. viduatus Fab. Eastern Kansas.
5633. carbonarius Hald. Topeka.
5641. luridus F. Lawrence.
5642. atomarius Mels. Topeka; common.
5644. infaustus Hald. Topeka.
5648. tridens Mels. Lawrence.
5650. sobrinus Hald. Topeka and Lawrence.
5653. livens Lec. Lawrence.
5660. abdominalis Say. Topeka.
5661. litigiosus Suffr. Wallace. (Snow.)

5663. othonus Say. Topeka and Lawrence.
— n. sp. Topeka; frequent.
— Two undetermined species; Topeka.

FIDIA, Baly.

5667. longipes Mels. Eastern Kansas; upon grape leaves.

XANTHONIA, Baly.

5668. decimnotata Say. Lawrence.
5669. villosula Mels. Topeka; common; brushed from oak leaves.

HETERASPIS, Chev.

5671. pubescens Mels. Topeka and Lawrence.
5672. marcassita Germ. Lawrence.
5673. nebulosus Lec. Topeka; on Gaura and Œnothera.
5675. curtipennis Mels. Topeka; frequent.

GLYPTOSCELIS, Lec.

5681. crypticus Say. Lawrence.

MYOCHROUS, Chev.

5685. denticollis Say. Eastern Kansas; common.
5687. squamosus Lec. Western Kansas.

CHRYSOCHUS, Chev.

5688. auratus Fab. Eastern Kansas; very common on Apocynum.

PARIA, Lec.

5694. sexnotata Say. Eastern Kansas.
5694b. quadrinotata Say. Eastern Kansas.
5695. aterrima Oliv. Topeka and Lawrence; extremely adundant.
5698. viridicyanea Cr. Eastern Kansas; common on Ipomea pandurata, and is also found on sweet potato vines.

METAPARIA, Cr.

5699. clythroides Cr. Mitchell county; very abundant on heads of Petalostemon.

METACHROMA, Chev.

5704. interrupta Say. Stockton, Rooks county. A variety of this species, having unspotted elytra, is found in the same locality.
5710. pallida Say. Eastern Kansas.

COLASPIS, Fab.

5714. favosa Say. Eastern and middle Kansas; common at Clay Center, on Psoralea argophylla.
5715. brunnea F. Eastern Kansas.
5715a. flavida Say. Eastern Kansas.
5716. prætexta Say. Lawrence and Topeka.
5719. tristis Oliv. Eastern and middle Kansas.
5719a. convexa Say. Topeka; common.
5719b. puncticollis Say. Lawrence.

CHRYSOMELA, L.

5722. clivicollis Kby., var. The spots are divided into numerous smaller ones, in all Kansas specimens that I have seen. Rare.
5724. decimlineata Say. Abundant throughout the State, preferring the leaves of Solanum rostratum to those of any other plant.
5729. exclamationis F. Throughout Kansas; abundant in the middle and western sections, but more rare in the eastern part. Found by me on Helianthus lenticularis and H. petiolaris only.
5730. conjuncta Rog., var. pallida Say. Western Kansas.
5732. saturalis Fab. Eastern Kansas.
5734. similis Rog. Eastern Kansas; common.
5736. præcelsis Rog. Lawrence.
5739. multiguttis Stål. Eastern Kansas; common on leaves of Corylus.
5740a. Spireæ Say. Topeka; on wild plum.
5741. multipunctata Say. Eastern Kansas.

GASTROPHYSA, Chev.

5753. polygoni L. Topeka and Lawrence.
5754. dissimilis Say. Lawrence.
5755. cyanea Mels. Eastern Kansas; on Rumex brittanica. Often very abundant.

PRASOCURIS, Latr.

5760. obliquata Cr. Western Kansas.

PLAGIODERA, Chev.

5766. lapponica L. Topeka and Lawrence; not common.
5768. scripta F. Eastern Kansas; on leaves of cottonwood and willow trees. Frequent.
5773. viridis Mels. Topeka; two specimens.

CEROTOMA, Chev.

5775. caminea F. Eastern Kansas; eats holes in the leaves of bush beans. Sometimes occurring in such numbers as to destroy the plants.

PHYLLOBROTICA, Redt.

5776. decorata Say. Topeka and Lawrence; rare.
5777. discoidea Say. Topeka and Lawrence; rare.

PHYLLECHTHRUS, Lec.

5780a. atriventris Say. Eastern Kansas.

LUPERUS, Geoff.

5788. varicornis Lec. Topeka; on composite flowers.

MONOCESTA, Clk.

5799. coryli Say. Leavenworth, Lawrence.

DIABROTICA, Chev.

5800. tricincta Say. Extreme western Kansas, on Cucurbita perennis; common.
5802. duodecimpunctata Oliv. Eastern and middle Kansas; abundant.
5806. vittata F. Eastern Kansas; abundant.
5809. longicornis Say. Eastern Kansas; common.
5811. atripennis Say. Eastern Kansas.

GALERUCA, Geoff.

5815. americana F. Topeka; rare, under stones in spring.
5815a. cribrata Lec. Topeka; found with the last and also swept from herbage; frequent.

MONOXIA, Lec.

5831. guttulata Lec. Western Kansas. (Cooper.)

TRIRHABDA, Lec.

5834b. canadensis Kby. Lawrence and Topeka.
5837. convergens Lec.(?) Topeka; found abundantly, both beetles and larvæ, on Xanthoxylum, at times defoliating the shrubs in a locality.

PACHYONCHUS, Chev.

5840. paradoxus Mels. Topeka; one specimen.

ŒDIONYCHIS, Latr.

5847. gibbitarsis Say. Eastern Kansas.
5849. octomaculata Cr. Lawrence.
5851. vians Ill. Topeka; rare.
5854. thoracica F. Eastern Kansas.
5859. thyamoides Cr. Topeka; frequent on Teucrium.

DISONYCHA, Chev.

5864. limbicollis Lec. Eastern Kansas.
5865. alternata Ill. Eastern and middle Kansas.
5866. punctigera Lec. Eastern Kansas; found in abundance on purslane.
5867. pennsylvanica Ill. Eastern Kansas; Rooks county. In the latter locality on Salix.
5870. abbreviata Mels. Eastern Kansas.
5873. triangularis Say. Topeka and middle Kansas.
5874. collaris F. Eastern Kansas; common on Chenopodium album.

GRAPTODERA, Chev.

5876. chalybea Ill. Lawrence; rare.
5886. foliacea Lec. Eastern Kansas; on Gaura; also found in Pueblo, Col.

LONGITARSUS, Latr.

5891. melanurus Mels. Topeka; common on Onosmodium.
—— n. sp. Topeka; on Onosmodium.

BATOPHILA, Foud.

5899. spuria Lec. Lawrence.

ORCHESTRIS, Kby.

5904. vittata Fab. Eastern Kansas; very abundant and destructive to garden Cruciferæ; found also on wild plants of the same order, especially Lepidium.

APHTHONA, Chev.

5911. picta Say. Topeka.
5912. texana Cr. Topeka; on Euphorbia marginata.

SYSTENA, Chev.

5914. hudsonias Forst. Topeka.
5921. blanda Mels. Eastern Kansas; on Xanthium.

ORTHALTICA, Cr.

5922. copalina F. Eastern Kansas; abundant on Rhus glabra.

CREPIDODERA, Chev.

5928. Helxines L. Eastern Kansas.

EPITRIX, Foud.

5933. cucumeris Harr. Eastern Kansas; abounds on Irish potato vines, as well as on Cucurbitaceæ.

CHÆTOCNEMA, Steph.

5942. denticulata Ill. Eastern Kansas. An undescribed species, near denticulata, occurs at Topeka.

BLEPHARIDA, Chev.

5953. rhois Forst. Eastern and middle Kansas; abundant.

STENISPA, Baly.

5955. collaris Baly. Topeka; one specimen.

ODONTOTA, Chev.

5957. scapularis Oliv. Topeka; two specimens, found on Corylus.
5961. rubra Web. Eastern Kansas.
5962. rosea Web. Topeka.

CHARISTENA, Baly.

5963. nigrita Oliv. Topeka.
—— One untetermined species; Topeka.

MICRORHOPALA, Chev.

5966a. lætula Lec. Eastern Kansas; Rooks Co. Common at Topeka, and found on Solidago rigida.
5969. cyanea Say. Rooks county, Smoky Hill and Arkansas valleys.

CHELYMORPHA, Chev.

5976. cassidea Fab. Eastern Kansas.

PHYSONOTA, Boh.

5979. unipunctata Say. Eastern Kansas; on Vernonia.

CASSIDA, Linn.

5980. nigripes Oliv. Eastern Kansas.
5981. bivittata Say. Eastern Kansas; infrequent.

COPTOCYCLA, Chev.

5986. aurichalcea Fab. Eastern Kansas.
5987. guttata Oliv. Eastern Kansas.
5990. clavata Fab. Eastern Kansas; found on leaves of Irish potato.

TENEBRIONIDÆ.

EDROTES, Lec.

5993. rotundus Say. "Found very early in spring, on warm days, in the sand-hills south of Dodge City and Cimarron Station." (Cooper.)

TRIMYTIS, Lec.

6002. pruinosa Lec. Extreme western Kansas, under "buffalo chips."

EPITRAGUS, Latr.

6010. canaliculatus Say. Western Kansas.

ASIDA, Latr.

6068. opaca Say. Western Kansas.
6070. polita Say. Western Kansas.
6071. sordida Lec. Western Kansas.
6092. convexa Lec. Western Kansas.
6097. elata Lec. Western Kansas.

OLOGLYPTUS, Lec.

6098. anastomosis Say. Western Kansas.

EUSATTUS, Lec.

6105. reticulatus Say. "Arkansas and Smoky Hill rivers, western part of Kansas." (Cooper.)

ELEODES, Esch.

6127. obscura Say. Western Kansas.
6128. acuta Say. Western Kansas.
6129. suturalis Say. Throughout Kansas.
6129a. texana Lec. "Western Kansas." (Cooper.)
6131. tricostata Say. Throughout the State.
6133. obsoleta Say. Western Kansas.
6137. extricata Say. Western Kansas.
6141. longicollis Lec. Western Kansas.
6150. hispilabris Say. Western Kansas.
6167. opaca Say. From Louisville westward; western Kansas generally.

EMBAPHION, Say.

6174. muricatum Say. Western Kansas; in Arkansas and Smoky Hill valleys.
6175. contusum Lec. Smoky Hill valley.

NYCTOBATES, Guer.

6199. pennsylvanica DeG. Eastern Kansas; abundant.

MERINUS, Lec.

6207. lævis Oliv. Lawrence and Topeka; not common.

HAPLANDRUS, Lec.

6209. femoratus Fab. Lawrence.

CENTRONOPUS, Sol.

6217. calcaratus Fab. Topeka.

XYLOPINUS, Lec.

6219. saperdioides Oliv. Eastern Kansas.

TENEBRIONELLUS, Cr.

6222. obscurus Fab. Eastern Kansas; frequent.
6223. molitor L. Eastern Kansas; frequent.
6224. castaneus Kn. Lawrence.

6225. tenebrioides Bv. Eastern Kansas; abundant.

BLAPSTINUS, Latr.

6244. pratensis Lec. Lawrence and Topeka.
6250. interruptus Say. Lawrence.

TRIBOLIUM, McL.

6265. ferrugineum Fab. Lawrence and Topeka; at the latter locality, found destroying the entomological specimens in the cabinets of the Academy of Science.

DIŒDUS, Lec.

6267. punctatus Lec. Lawrence and Topeka.

THARSUS, Lec.

6281. seditiosus Lec. Specimens collected at Tonganoxie, by Mr. T. B. Ashton.

PHALERIA, Latr.

6283. imberbis Lec. Eastern Kansas; common.

ANÆDUS, Bl.

6289. brunneus Zieg. Topeka; one specimen.

PARATENETUS, Spin.

6292. fuscus Lec. Topeka; frequent in spring under stones.

DIAPERIS, Geoff.

6308. hydni Fab. Eastern Kansas.

HOPLOCEPHALA, Lap.

6310. viridipennis F. Eastern Kansas; not common.
6311. bicornis Oliv. Eastern Kansas; common.

PLATYDEMA, Lap.

6312. excavatum Say. Eastern Kansas.
6316. ruficorne Sturm. Eastern Kansas.
6317. flavipes Fab. Lawrence.
6319. ellipticum Fab. Eastern Kansas; rare.
6325. subcostatum Lap. Eastern Kansas.

PHYLETHUS, Meg.

6326. bifasciatus Say. Lawrence.

BOLITOTHERES, Cand.

6334. bifurcus Fab. Eastern Kansas; common.

RHIPIDANDRUS, Lec.

6338. paradoxus Bv. Topeka.

STRONGYLIUM, Kby.

6336. tenuicolle Kby. Lawrence.

ALLECULIDÆ.

ALLECULA, Fab.

6372. punctulata Mels. Topeka and Lawrence.

HYMENORUS, Muls.

6374. pilosus Mels. Topeka.
6375. obscurus Say. Lawrence.
6377. niger Mels. Topeka.
6378. communis Lec. Lawrence.
6382. punctatissimus Lec. Topeka.

LAGRIIDÆ.

STATIRA, Latr.

6411. gagatina Mels. Topeka; frequent.

PYROCHROIDÆ.

PYROCHROA, Geoff.

6419. flabellata F. Eastern Kansas.

ANTHICIDÆ.

EURYGENIUS, Laf.

6427. Wildii Lec. Lawrence and Topeka.
6428. murinus Hald. Lawrence and Topeka.

STEREOPALPUS, Laf.

6430. Mellyi Laf. Topeka and Lawrence.
6431. badiipennis Lec. Lawrence.

CORPHYRA, Say.

6441. pulchra Lec. Topeka.

MACRATRIA, Newm.

6449. murina Fab. Topeka; rare.

NOTOXUS, Geoff.

6455. monodon Fab. Eastern Kansas; common.
6464. planicornis Laf. Lawrence.

TOMODERUS, Laf.

6466. interruptus Laf. Topeka.
6468. constrictus Say. Topeka.

ANTHICUS, Leach.

6474. formicarius Laf. Topeka; common.
6475. cinctus Say. Topeka and Lawrence.
6493. cervinus Laf. Eastern Kansas; very abundant in winter under rubbish.

MELANDRYIDÆ.

SCRAPTIA, Latr.

6530. sericea Mels. Lawrence.

CANIFA, Lec.

6532. plagiata Mels. Topeka; common.

PENTHE, Newm.

6539. obliquata Fab. Eastern Kansas.
6540. pimelia Fab. Eastern Kansas.

OSPHYA, Ill.

6542. varians Lec. Topeka and Lawrence.

HYPULUS, Payk.

6557. liturata Lec. Topeka and Lawrence.

HALLOMENUS, Panz.

6562. scapularis Mels. Topeka; rare.

EUSTROPHUS, Ill.

6567. confinis Lec. Lawrence.
6568. bicolor Say. Eastern Kansas.
6569. bifasciatus Say. Eastern Kansas.
6570. tomentosus Say. Topeka and Lawrence.

MORDELLIDÆ.

PENTARIA, Muls.

6575. trifasciata Mels. Eastern Kansas.

MORDELLA, Linn.

6593. melæna, Germ. Topeka and Lawrence.
6594. scutellaris Fab. Lawrence; Rooks county.
6597. octopunctata Fab. Topeka; rare.
6598. marginata Mels. Topeka.
6599. lineata Mels. Topeka; common.
6602. oculata Say. Lawrence.

GLIPODES, Lec.

6607. sericans Mels. Lawrence.

MORDELLISTENA, Costa.

6611. lutea Mels. Topeka.
6619. ornata Mels. Topeka.
6621. scapularis Say. Topeka.
6647. ambusta Lec. Topeka.
6650. divisa Lec. Topeka and Lawrence; common.
—— Several undetermined species.

MACROSIAGON, Hentz.

6667. dimidiata Fab. Lawrence.
6668. flavipennis Lec. Topeka.

EMMENADIA, Laf.

6672. pectinata F. Topeka and Lawrence.
6673. Sayi Lec. Topeka and Lawrence.
6678. limbata F. Lawrence.

MELOIDÆ.

MELOE, L.

6693. impressus Kby. Lawrence.
6699. angusticollis Say. Eastern Kansas.

HENOUS, Hald.

6703. confertus Say. Eastern and middle Kansas.

TRICRANIA, Lec.

6711. Stansburii Hald. Western Kansas. (Snow.)

MACROBASIS, Lec.

6713. albida Say. Western Kansas.
6719. unicolor Kby. Eastern Kansas, on Astragalus caryocarpus.
6721. immaculata Say. Western Kansas.
6722. segmentata Say. Western Kansas.

EPICAUTA, Redt.

6729. convolvuli Mels. Topeka; one specimen.
6731. ferruginea Say. Western Kansas; Rooks county and Ellinwood. Found on composite flowers.
6732. sericans Lec. Eastern Kansas.
6734. callosa Lec. Rooks county.
6738. maculata Say. Middle and western Kansas.
6739. vittata F. Eastern Kansas.
6744. cinerea Forst. Eastern Kansas.
6746. corvina Lec. Western Kansas; very destructive in gardens, with Nos. 6713, 6721, 6722, 6738, devouring the leaves of potatoes, turnips, beets, etc. Pea vines are left untouched by them, so far as observed.
6747. pennsylvanica Deg. Eastern Kansas; very abundant in fall upon the flowers of Golden Rod (Solidago rigida).

PYROTA, Lec.

6750. mylabrina Chev. "Arkansas and Smoky Hill valleys." (Cooper.)
6751. Engelmanni Lec. Western Kansas.

CANTHARIS, L.

6791. sphæricollis Say. Rooks county, on Symphoricarpus occidentalis.

ZONITIS, Fab.

6803. atripennis Say. Western Kansas.
6805. bilineata Say. Eastern and middle Kansas, on Helianthus.

NEMOGNATHA, Ill.

6810. apicalis Lec. Western Kansas.
6816. piezata Fab. Two specimens received from T. B. Ashton, Tonganoxie.
6821. nigripennis Lec. Western Kansas. (Snow.)
6825. immaculata Say. Eastern and western Kansas.
6826. vittigera Lec. Eastern Kansas; Rooks Co.

GNATHIUM, Kby.

6830. minimum Say. Found by the writer on the Saline river, in Russell county, in abundance. Also at Pueblo, Col.; in both localities on heads of Helianthus.

ŒDEMERIDÆ.

OXACIS, Lec.

6848. cana Lec. Eastern and middle Kansas.

ASCLERA, Schmidt.

6861. ruficollis Say. Topeka.
6862. puncticollis Say. Eastern Kansas.

RHYNCHITIDÆ.

EUGNAMPTUS, Sch.

collaris Fab. Topeka; one specimen.

RHYNCHITES, Hb.

bicolor Fab. Eastern Kansas; common on wild roses.
æneus Boh. Eastern Kansas.

ATTELABIDÆ.

ATTELABUS, L.

analis Ill. Eastern Kansas; found on Rhus glabra, and rolls the leaflet, beginning at the point. The eggs, as I believe, are laid in punctures in the midrib.

BYRSOPIDÆ.

THECESTERNUS, Say.

humeralis Say. Throughout the State in its varieties, and apparently not rare.

OTIORHYNCHIDÆ.

MINYOMERUS, Horn.

inneeuus Horn. Topeka.

GRAPHORINUS, Sch.

vadosus Say. Eastern Kansas.

EPICÆRUS, Sch.

imbricatus Say. Rather common in eastern and middle Kansas.

OPHRYASTES, Sch.

vittatus Say, Western Kansas.
tuberosus Say. Western Kansas.
latirostris Lec. Western Kansas.
sulcirostris Say. Western Kansas.

ANAMETIS, Horn.

grisea Horn. Lawrence, Topeka, and West.

PHYXELIS, Sch.

rigidus Say. Topeka.

OTIORHYNCHUS, Germ.

Species undetermined. Lawrence.

DIROTOGNATHUS, Horn.

An undescribed species. Topeka.

TANYMECUS, Sch.

confertus Gyll. Eastern Kansas; common.

ARAMIGUS, Horn.

tesselatus Say. Eastern and middle Kansas.

PHACEPHOLIS, Horn.

elegans Horn. Topeka and Lawrence.
candida Horn. Western Kansas; also at Topeka.

APHRASTUS, Sch.

tæniatus Say. Topeka.

CYPHOMIMUS, Horn.

dorsalis Horn. Topeka; beaten from budding oaks.

CURCULIONIDÆ.

SITONES, Sch.

lineellus Gyll. Topeka; two specimens.
flavescens Allard. Lawrence.

PHYTONOMUS, Sch.

comptus Say. Topeka; one specimen.
eximius Lec. Topeka; not common. Found on leaves of Rumex brittanica. The pupal stage is passed in a cocoon spun by the larva, on the leaf-surface, usually next to a rib. The cocoon is formed of yellow-brown threads, loosely interwoven, so that

the fabric resembles network. It is broad oval in outline. The pupa within is very nervous, and twists around rapidly when the leaf is touched. Of the larval habits I have observed nothing.

LISTRONOTUS, Jekel.

nebulosus Lec. Lawrence.
latiusculus Boh. Topeka; frequent; found under stones in spring, and on Peucedanum fæniculaceum.

MACROPS, Kby.

Several undetermined species, taken at Topeka.

CLEONUS, Sch.

trivittatus Say. Western Kansas.
frontalis Lec. Topeka; one specimen.
carinicollis Lec. Western Kansas.

LIXUS, Fabr.

punctinasus Lec. Topeka.
terminalis Lec. Topeka, on Polygonum amphibium.
mucidus Lec. Topeka and Lawrence.
concavus Say. Eastern Kansas.
musculus Say. Topeka.
macer Lec. Eastern Kansas; frequent.
An unnamed species. Topeka.

DORYTOMUS, Sch.

mucidus Say. Eastern Kansas.
An undetermined species. Topeka.

DESMORIS, Lec.

constrictus Say. Eastern and middle Kansas, on Helianthus.
scapalis Lec. Lawrence.

SMICRONYX, Sch.

fulvus Lec. Topeka; common on Helianthus lenticularis.

OTIDOCEPHALUS, Chev.

An undetermined species. Lawrence.

MAGDALIS, Germ.

armicollis Say. Lawrence and Topeka.
subtinctus Lec. Topeka.

ANTHONOMUS, Germ.

quadrigibbus Say. Lawrence.
fulvus Lec. Topeka and western Kansas.
signatus Say. Topeka.
nigrinus Boh. Topeka.

MACRORHOPTUS, Lec.

estriatus Lec. Western Kansas; breeds in the seeds of Cullirhæ involucrata.

TYCHIUS, Sch.

sordidus Lec. Western Kansas.

CONOTRACHELUS, Sch.

nenuphar Hb. Eastern Kansas.
retentus Say. Topeka.
seniculus Lec. Topeka; common.
affinis Boh. Topeka and Lawrence.
nivosus Lec. Topeka; found on Euphorbia corollata abundantly.
adspersus Lec. Topeka and Lawrence; on Helianthus.
posticatus Say. Topeka and Lawrence.
anaglypticus Say. Topeka.
leucophæatus Fahr. Topeka.

RHYSSEMATUS, Sch.

lineaticollis Say. Topeka and Rooks county.

CHALCODERMUS, Sch.

æneus Boh. Topeka.

TYLODERMA, Say.

foveolatum Say. Eastern Kansas; frequent at Topeka, and found on Gaura.
æreum Say. Eastern Kansas; more common than the last named, and found on the same plant.

CRYPTORHYNCHUS, Ill.

bisignatus Say. Topeka.
obtentus Hb. Topeka.
tristis Lec. Topeka.

PIAZURUS, Sch.

oculatus Say. Topeka.

COPTURUS, Sch.

operculatus Say. Topeka and Lawrence.

CŒLIODES, Sch.

curtus Say. Topeka.
acephalus Say. Topeka; on Gaura and Œnothera; common.
cruralis Lec. Topeka.

CEUTORHYNCHUS. Germ.

sulcipennis Lec, Topeka.

RHINONCUS, Sch.

pericarpius L. Topeka; frequent.
pyrrhopus Boh. Eastern Kansas; common on Polygonum.

ORTHORIS, Lec.

Crotchii Lec. Western Kansas.

TRICHOBARIS, Lec.

texana Lec. Topeka and westward; on Helianthus.
trinotata Say. Eastern Kansas; common.

AULOBARIS, Lec.

naso Lec. Topeka.

BARIS, Germ.

strennua Lec. Topeka.

ONYCHOBARIS, Lec.

subtonsa Lec. Topeka; abundant on Oxybaphus nyctagineus.

PSEUDOBARIS, Lec.

farcta Lec. Eastern Kansas; on Salvia Pitcheri.
angusta Lec. Topeka.

MADARUS, Sch.

undulatus Say. Topeka.

CENTRINUS, Sch.

scutellum-album Say. Eastern Kansas.
penicellus Hb. Eastern Kansas.
perscillus Gyll. Topeka.
picumnus Hb. Topeka.
decipiens Lec. Western Kansas.

BALANINUS, Germ.

nasicus Say. Eastern Kansas.

BRENTHIDÆ.

EUPSALIS, Lac.

minuta Drury. Eastern Kansas.

CALANDRIDÆ.

SPHENOPHORUS, Sch.

callosus Oliv. Topeka.
parvulus Gyll. Topeka and Lawrence.
sculptilis Uhl. Topeka.
costipennis —. Topeka.
cultellatus —. Lawrence and Topeka.
scoparius —. Lawrence.
vomerinus Lec. Western Kansas.
Two undetermined species.

RHODOBÆNUS, Lec.

tridecimpunctatus Ill. Common throughout the State; most frequently found on ironweed (Vernonia) at Topeka.

CALANDRA, Clairv.

oryzæ F. Topeka; one specimen.
granaria F. Topeka. Introduced in grain

from the United States Department of Agriculture, but fortunately detected before the grain was sown. I know of no weevil infested granaries in this neighborhood.

DYROPHTHORUS, Sch.

corticalis Say. Topeka; in decayed wood.

COSSONUS, Clairv.

corticola Say. Lawrence and Topeka; found under bark.

SCOLYTIDÆ.

XYLEBORUS, Eich.

celsus Eich. Lawrence and Topeka.
xylographus Say. Lawrence and Topeka.

ANTHRIBIDÆ.

CRATOPARIS, Sch.

lunatus Fab. Eastern Kansas.

BRACHYTARSUS, Sch.

variegatus Say. Topeka; occasional.

APIONIDÆ.

APION, Hb.

segnipes Say. Topeka.
sp. undet. Topeka; on Psoralea floribunda.
sp. undet. Topeka; on Helianthus lenticularis.

CENTENNIAL CATALOGUE OF THE PLANTS OF KANSAS.

By Prof. James H. Carruth, of Lawrence.

It is not supposed that the botanical survey of Kansas is by any means complete. Not including the Cryptogamia below the Filices, Porter & Coulter's Flora of Colorado contains the names of about 1,050 species; Colman's catalogue of Michigan Southern peninsula, 1,375. Wood's Class-Book gives east of the Mississippi, including the South Atlantic and Gulf States, about 3,900. I have understood that Prof. Aughey, of Lincoln College, Neb., has a catalogue for that State of about 1,600. This may include the lower Cryptogamia. Probably we have in Kansas 1,200 to 1,500. We already have the names of about 1,080. Of these I have seen about 900. We have more to do. But, it being the centennial year, it has been thought advisable to have a centennial catalogue, including the species already known. I have not seen all of which I give the names, but shall give none of which I do not think I have reliable information. In such cases I shall give the names of my informants. Many of those heretofore given on the authority of others I have myself since seen, and give them as of my own knowledge.

OBSERVERS.

I have not traveled widely, but have been greatly aided by the observations of others. Before 1871, Mr. E. Hall, of Illinois, journeyed in Kansas, and published his observations. Prof. Snow, of the State University, and his students, have had their eyes open, and seen many plants. W. H. Saunders, M. D., recently of Lawrence, has reported a goodly number. In 1874 and 1875, L. Watson, M. D., sent me 400 to 500 species, often many specimens of each; a few this year. Mr. J. Henry, of Salina, sent me in 1875 about 150 species. Mr. E. A. Popenoe, of Topeka, has traveled in western Kansas, and reported quite a number. Prof. Mudge has sent some species. In 1876, W. S. Newlon, M. D., of Oswego, sent me about 200; a few in 1875. Mrs. Jewell (Miss E. C. Wright), of Irving, has sent several, and reported more. In 1874, Miss M. P. Wright, of Burlington, brought me about a dozen, four of which I have not seen here. I am indebted to Mr. James Wilson, of Leavenworth, for specimens of nearly all the ferns hitherto found in Kansas. A few other names will be found in the catalogue.

INSTRUCTORS.

We are out of the field of Wood and Gray, and many of our plants are not in their books. This is especially true of those of Western Kansas. I have been greatly aided in determining Western plants by Porter & Coulter's Flora of Colorado, which Dr. Watson put me in the way of getting. But some plants are in no book which I have. Again, Western plants are often small, and, when dry, difficult to determine. Again, plants do not always grow according to the books, and then it is not easy to tell whether they are varieties of species described in books which I have, or species of which I have no description. In such cases, I have had the help —which I gladly acknowledge—of Prof. Wood, Mr. E. Hall, and Mr. S. Watson. Also, in 1873, Dr. S. H. Wright, of Penn Yan, N. Y., aided me in the Cyperaceæ.

CHARACTERISTICS OF THE FIELD.

Our flora differs considerably from that of the Eastern States. We have no peat swamps, and, consequently, lack the plants peculiar to such places. I have never seen in Kansas a specimen of the large order Ericaceæ, including the huckleberry, cranberry, wintergreen, rhododendron, azaleas, etc. A year or two ago, a specimen of Indian pipe, or ghost flower, was reported in Douglas county; and lately I learn that the huckleberry grows in the southeast corner of the State. The chestnut, beech and alder are not found native, so far as I know. The black birch is found in southeast Kansas. The tulip tree and magnolia are wanting. The only evergreen is red cedar, and this is very rare. I once thought the Cyperaceæ were rare, but find there are many species, though few are very abundant. Leguminosæ, Compositæ, and grasses abound. We have most of the oaks and hickories. Ferns, mosses, lichens and fungi are not numerous, and ground pines are wanting.

CHANGES OF PLANTS.

The introduction of civilized society into Kansas has brought many plants not found on the prairies. The burdock, dandelion, plantain, mayweed, knotgrass, and many others that grow about buildings and on roadsides, stick to civilized man like his vices. In consequence of the disappearance of the buffalo, our taller grasses are moving westward, and taking the place of the buffalo grass. In older places, where cattle feed much, these same grasses are killed out, and their places occupied by the soft carpet of the many-jointed drop-seed grasses.

Some plants appear and disappear from causes not very manifest—perhaps difference of seasons. In 1875, the Solanum rostratum, a prickly plant with yellow flowers, occupied nearly all the vacant land in Lawrence. In 1876 it is very rare. In 1875 I scarcely saw the clammy ground-cherry at all; this year it has come back again. Some plants found, though rarely, years ago, I have not seen for a long time.

USE OF BOTANY.

Some people do not know any use of botany but to please young ladies. It shows us the fingerwork of the Almighty, in which He takes pleasure. He certainly did not make all these things for our pleasure, for many of them we never see, or do not notice. But, if He takes pleasure in them, it is not an unworthy subject of study. And it is not without utility. One

person will transplant a wild grapevine expecting fruit, when it is a staminate vine and can never be productive. Another will set out a whole garden full of pistillate strawberries, and wonder why there is no fruit. Another will cut off the "false blossoms" of the cucumber to make them bear better. Another will plant different varieties of corn, melons, etc., near each other, and wonder why they mix. Another, having learned that they do mix, wonders why potatoes do not mix. A little knowledge of botany would explain these things.

SPECIES, OR VARIETIES.

For some years past botanists have been inclined to regard forms of plants, which had been considered distinct species, as only varieties of the same. Thus Polygonum erectum has been regarded as only a variety of P. aviculare; Amarantus blitum of A. albus; Physalis lanceolata of P. Pennsylvanica; P. nyctaginea of P. viscosa, and Vitis riparia of V. cordifolia. I think this tendency arises from studying plants in the herbarium rather than in the field. Some characters of a plant do not always appear in the small portion detached for the herbarium. Tint of color, sometimes of no account as a mark, is sometimes constant and characteristic, and yet may not appear in the dried specimen. A leaf which shines when growing may appear dull when dry. So of odor or viscidity. The habit or mode of growth of a plant may not appear in a branch. It may require close observation of plants in the field to determine some of these cases. I think that if two forms of the same family grow often near each other without ever graduating into each other, however similar, they should be regarded as distinct species. The botanists, so far as I know, give us but one species of pumpkin, Cucurbita pepo. I have seen the common red pumpkin varying in tint of red; and flat, round or oblong. I have often seen, in the same field, the cream-colored pumpkin with deeper-colored flesh, varying in the same way in form, but I never saw an intermediate. I never saw the former with spotted leaves, nor the latter without them. I believe them to be distinct species. But, if an intermediate form is seen, it does not prove the two to be identical, for the intermediate may be a distinct species different from either, or it may be a hybrid that will soon return to its original type. Botanists speak of hybrids between Verbena stricta and V. angustifolia. I think I have seen such about half-way between both.

Polygonum aviculare and P. erectum may be hard to distinguish in hand specimens, but let any one see them growing together, the latter growing up through a patch of the former, and it will be hard to regard them as only varieties. The difference in tint of color, shape of leaf and mode of growth is constant, and I am glad to see that Mr. S. Watson restores P. erectum to its place.

Amarantus blitum had a place in Eaton and in older editions of Wood, but of late has disappeared, and it made me a good deal of trouble to find it out. Dried branches of both are hard to distinguish. Both have a very narrow border of white around the leaves. But A. albus stands or sits erect, sending out stiff branches all the way up. It rots off in the fall, and is to be seen all winter blown against the fences. A. blitum lies flat on the ground like puhslane, and, when killed by frost, is soon rotten. This, too, I am glad to see, Mr. S. Watson considers entitled to its old place.

Physalis Pennsylvanica and P. lanceolata have leaves and blossoms very similar. But P. lanceolata is puberulent, branching from the ground, ascending, about ten inches high. P. Pennsylvanica has a smooth, clear,

erect stem for about a foot, and then branches for about another foot. P. lanceolata has the fruit calyx deeply concave at base, like the inside of a hollow hemisphere. P. Pennsylvanica always has the calyx truncate at base, or the radiating vines curving outward. I cannot believe them identical.

If I rightly apply the names, P. viscosa and P. nyctaginea have leaves similar in form, though not in size, and have blossoms very small, three or four lines in diameter, and fruit calyx roundish. But P. viscosa sends out its strong arms almost horizontally, one and one-half feet; the leaves are brownish green, the flowers have a brown center, and the fruit calyx is five-angled. P. nyctaginea forks at every joint, the leaves are yellowish-green, flowers all yellow, and fruit calyx ten-angled. It is viscid and odorous—points not noticed in the only description I have, that of Wood's Botanist and Florist.

Another Physalis grows here, which Dr. Gray and Mr. Watson refer to P. lanceolata, Dr. Gray calling it variety hirta. It branches from the ground like that, and the stem is weak and leaning, but the leaves are always rhombic-oval, entire; the flowers are all yellow, and the fruit calyx is more like that of P. pubescens. It never varies into any other, and answers to no description which I have seen.

Vitis cordifolia and V. riparia were once regarded as distinct species, but have long been considered only varieties. Dr. Gray says Dr. Engelmann thinks V. riparia should be restored. The very brief descriptions of Eaton are all that I have seen of each as distinct. Since they have been regarded as one, the description of the united species will not apply to both. V. cordifolia, of the books, is distinguished from V. vulpina by saying that the latter has leaves shining, especially below; while the leaves of the former are dull. Also, fruit ripe in October. The Vitis common here, which I take to be V. riparia, has leaves shining on both sides, gash-toothed, with acuminate teeth; fruit clusters compact, ripe in July and August, and very pleasant. Two plants, quite different from this, observed two years ago, were destroyed. I have found another this year—leaves dull, dark green above, teeth crenate, mucronate; fruit ripe in October, and, as Dr. Gray says of V. cordifolia, "very acerb." I suppose this to be V. cordifolia, and cannot but think the two are distinct species.

Dr. Gray thinks Helianthus doronicoides the original of H. tuberosus, the artichoke. When I came to Kansas I found Helianthi looking very much like artichokes, but on examination found no tubers. Last year I found what appeared to be H. doronicoides, with small tubers. Farmers plow them up. Last spring I sent East and got artichokes, which have grown well and blossomed. The very early frost prevented me from comparing them with the wild as fully as I had intended. I have observed no difference, unless it be that the disks of the wild, in fruit, are larger. Gray describes only H. doronicoides; Eaton only H. tuberosus. Wood has both, but his descriptions do not decidedly differ, only in that of H. doronicoides no mention is made of tubers. If there is a H. doronicoides always without tubers, I should consider them distinct. As it is, I wish to observe further.

CUTTING POTATOES.

For some years I cut potatoes, as others did, into small pieces for planting, and uniformly had a large part of them rot, some varieties more than others. Why was it? I think I understand it.

In August, a nurseryman may take any bud from a branch of the same

Cristatella.

69. †C. Jamesii T. & G. Phillips Co.: Popenoe.

VIOLACEÆ.

Viola, Violet.

70. V. delphinifolia Nutt. Law.
71. V. cucullata Ait. Law., Ell.
72. V. sagittata Ait. Law.. Snow; one specimen.
73. V. pubescens Ait. Law.
— V. pubescens Var. eriocarpa. Osw.
74. †V. Nuttallii Ph. Ell.

HYPERICACEÆ.

Hypericum, St. John's-wort.

75. H. perforatum L. Osw.
76. H. corymbosum Muhl. Law., Osw.
77. H. ellipticum Hook. Osw., Burl.
78. H. angulosum Mx. Osage Co.: Snow.

CARYOPHYLLACEÆ.

Saponaria, Soap-wort.

79. S. Vaccaria L. Topeka; brought by Mr. H. H. Wright.

Silene, Catch-Fly.

80. S. stellata Ait. Law., Osw.
81. S. antirrhina L. Law., Sal.

Agrostemma, Corn-cockle.

82. *A. Githago L. Top.: Popenoe.

Cerastium, Mouse-ear Chickweed.

83. C. viscosum L. Law.: Snow.
84. C. nutans Raf. Law.

Arenaria.

85. A. (Alsine) stricta Mx. Ell.
86. A. (Alsine) patula Gr. Osw.

Paronychia, Nailwort.

87. †P. Jamesii T. & G. Ell., Sal., Rooks Co.: Popenoe.
88. P. Canadensis Wood. Law.
— P. Canadensis var. pumila (Anychia dichotoma, DC.) Top.: Popenoe.

Mollugo, Carpet-weed.

89. M. verticillata L. Law., Osw.

PORTULACACEÆ.

Portulaca, Purslane.

90. *P. oleracea L. Law.

Talinum.

91. †T. parviflorum Nutt. Law.; might be taken for T. teretifolium, but has only five stamens.

Claytonia, Spring Beauty.

92. C. Virginica L. Osw.

MALVACEÆ.

Malva, Mallow.

93. *M. rotundifolia L. Law.
94. *M. crispa L. Law.; seen once.
95. M. papaver Cav. Ell.

Callirrhoe.

96. †C. involucrata Gr. Sal. and Russell Co.: Snow. Is it the same as 95?
97. C. alcæoides Gr. (Sida of Mx.) Osw., Sal., Burl.

Malvastrum.

98. †M. angustum Gr. Ell.
99. †M. coccineum Gr. Ell.; said to be abundant in Cent. and W. Kansas.

Sida.

100. S. spinosa L. Law., Burl.

Abutilon, Indian Mallow.

101. *A. Avicennæ Gaetrn. Law.

Hibiscus.

102. *H. trionum L., flower-of-an-hour. Law.
103. H. militaris Cav. Law.

TILIACEÆ.

Tilia, Linden.

104. T. Americana L., basswood. Law.

LINACEÆ.

Linum, Flax.

105. L. sulcatum Riddell. Law., Ell., Osw.
105. †L. rigidum Ph. Ell., Sal.

ZYGOPHYLLACEÆ.

Kallstræmia.

108. K. maxima T. & G. (Tribulus L.) W. Kansas: Popenoe.

GERANIACEÆ.

Geranium, Crane's-bill.

108. G. Carolinianum L. Law., Burl.
109. G. maculatum L. Leav.: Prof. Wherrell.

Oxalis, Wood Sorrel.

110. O. violacea L. Law.
111. O. stricta L. Law.

Impatiens, Touch-me-not.

112. I. pallida Nutt. Law.
113. I. fulva Nutt. Law., Osw.

RUTACEÆ.

Zanthoxylum, Prickly Ash.

114. Z. Americanum Miller. Law., Osw.

Ptelea, Shrub Trefoil.

115. P. trifoliata L. Anderson Co.: J. M. Welch.

ANACARDIACEÆ

Rhus, Sumac.

116. R. glabra L. Law., Ell.
117. R. copallina L. Law.
118. R. Toxicodendron L., poison ivy. Law.
119. R. radicans L., climbing ivy. Law.
120. R. aromatica Ait., sweet sumac. Law., Ell., Osw.

SAPINDACEÆ.

Acer, Maple.

121. A. dasycarpum Ehrh., white maple. Law.
122. A. saccharinum L. Linn and Miami counties.

Negundo, Box Elder.

123. N. aceroides Mœnch. Law.

Æsculus, Horse Chestnut.

124. A. glabra Willd., Ohio buckeye. Law.

Staphylea, Bladder Nut.

126. S. trifoliata L. Law., Irving.

CELASTRACEÆ.

Celastrus, Staff Tree (incorrectly called Bittersweet).

128. C. scandens L. Law., Sal., Osw.

Euonymus, Burning Bush.

128. E. atropurpureus Jacq. Law., Osw.

RHAMNACEÆ.

Ceanothus, Jersey Tea.

129. C. Americanus L. Law.
130. C. ovalis, Bigel. Law., Ell.

Rhamnus, Buckthorn.

131. R. lanceolatus Ph. Law., Osaw.

VITACEÆ.

Vitis, Grapevine, etc.

132. V. æstivalis L. Law.; one vine, that was rust-downy beneath. Said to be common in S. E. Kansas.
—— var. or sp. cinerea of Engelmann, if I mistake not. Law. and Miami county; very common.
133. V. cordifolia Mx., frost grape. Law. (See introduction.)
134. V. riparia Mx. Law., Ell., and Miami county; very common. (See introduction.)
135. V. vulpina L., muscadine grape. Near Baxter Springs: Mr. N. D. Ingraham.
136. V. indivisa Willd., (Cissus). Law.
137. V. quinquefolia Lam. (Ampelopsis.) Virginia creeper. Law., Osaw.

POLYGALACEÆ.

Polygala, Milk-wort.

138. P. incarnata L. Law.
130. P. verticillata L. Law. Osborne City: Popenoe.
140. P. sanguinea L. Burl.: from H. H. Wright.
141. †P. alba Nutt. Ell.

LEGUMINOSÆ.

Schrankia, Sensitive Brier.

142. S. uncinata Willd. Law.

Desmanthus.

143. D. brachylobus Benth. Law., Ell., Osw.

Gymnocladus, Coffee Tree.

144. G. Canadensis Lam. Law.

Gleditschia, Honey Locust.

145. G. triacanthos L. Law., Osaw.

Cassia, Senna.

146. C. Chamæcrista L. Law., Osaw.
147. C. nictitans L. Fort Leavenworth: Lieut. Wilcox.
148. C. Marilandica L. Law., Osw., Osaw.

Cercis, Red Bud.

149. C. Canadensis L. Law., Osaw.

Baptisia, Wild Indigo.

150. B. leucophæa Nutt. Law., Osw.
151. leucantha T. & G. Law.
152. B. australis R. Br. Garnett: Snow.

Lathyrus, Sweet Pea, &c.

153. L. linearis Nutt. Law., Ell.

Vicia, Vetch.

154. V. Americana Muhl. Law.

Desmodium, Bush Trefoil.

156. D. acuminatum DC. Law.
157. D. paniculatum DC. Law., Osw.
158. D. cuspidatum T. & G. Law.
159. D. canescens DC. Law.
160. Canadense DC. Law., Leav. Nearly sessile, a point not noted.
161. D. sessilifolium T & G. Law.
162. D. Marilandicum Nutt. Osw.
163. †D. Illinoiensis Gr. Law.
164. †D. neglectum Hall. Law. Mr. Hall thinks it is a species.

Lespedeza, Bush Clover.

165. L. capitata Mx. Law., Osw.
—— L. capitata var. angustifolia. Ph., Ell.
166. L. violacea Pers. Law.
—— L. violacea var. divergens. Osw.
—— L. violacea var. sessiliflora. Osw.
167. L. repens T. & Gr. Law.

Crotalaria, Rattle-pod.

168. C. sagittalis L. Law.

HOSACKIA.

169. †H. Purshiana Benth. Sal.

Trifolium, Clover.

170. T. procumbens L., Yellow Clover. Top.: Popenoe.
171. *T. repens L., White Clover. Law.
172. T. reflexum L., Buffalo Clover. Law., Osw.
173. *T. arvense L. Top.: Popenoe. One specimen.

Melilotus, Sweet Clover.

174. *M. alba Law. Law., Ell.

PSORALEA.

175. P. floribunda Nutt. Law., Ell., Osw.
176. †P. argophylla Ph. Law.; pretty.
177. †P. esculenta Ph. Law., Ell. Has an eatable tuber.
178. †P. cuspidata Ph. Ell.
179. †P. digitata Nutt. Hutchinson: Popenoe.

Amorpha, Lead Plant.

180. A. fruticosa L. Law., Ell., Osw.
181. A. canescens Nutt. Law., Osw.

DALEA.

182. D. alopecuroides Willd. Law.
183. †D. laxiflora Ph. Ell., Sal. Calyx beautifully fringed.
184. †D. aurea Nutt. Ell., Sal., Phillips and Rooks Co.: Popenoe.

PETALOSTEMON.

185. P. violaceum Mx. Law., Ells., Osw.
186. P. candidum Mx. Law., Osw.
187. †P. multiflorum Nutt. Law., Ell.; rocky places.
188. †P. villosum Nutt. Solomon City: Popenoe.

Astragalus, Milk Vetch.

189. A. Canadensis L. Law., Ells., Osw.
190. A. caryocarpus Kerr. Law., Ell., Osw., Sal.
191. A. Mexicanus DC. Law.: Snow.
192. †A. mollissimus Torr. Ell.
193. †A. racemosus Ph. Ell.
194. †A. gracilis Nutt. Ell.
195. †A. lotiflorus Hook. Ell., Sal.
196. †A. Missouriensis Nutt. Ell.
197. †A. Shortianus Nutt. W. Kan.: Popenoe.
198½. †A. bisulcatus Gr. W. Kan.: Popenoe.
199. †A. pectinatus Dougl. Ell., Osw.; also, W. Kan.: from Prof. Mudge.

Oxytropis.

200. †O. Lamberti Ph. Ell., Sal.

Glycyrrhiza, Licorice.

201. †A. lepidota Nutt. Ell., Law.: Snow. Marshall Co.: W. J. McLaughlin. Pod covered with hooks. Topeka; common: Popenoe.

Sophora.

202. †S. sericea Ph. Ell., Sal.

Tephrosia, Goat's Rue.

203. T. Virginiana Pers. Law.

Indigofera, Indigo Plant.

204. I. Caroliniana Walt. Osw.: Dr. Newlon.

Robinia, Locust.

205. *R. Pseudacacia L. Law.

Wistaria.

206. W. frutescens DC. Irving: Mrs. Jewell. Atchison Co.: Miss E. F. Randolph.

Apios, Ground Nut.

207. A. tuberosa Ph. Law., Osaw.

Phaseolus, Kidney Bean.

208. P. diversifolius Pers. Law., Osw., Sal.
209. P. pauciflorus Benth. Law.

Amphicarpæa, Pea-Vine.

210. A. monoica Nutt. Law., Irv.
211. A. Pitcheri T. & G. Law.

Hoffmanseggia.

212. †H. Jamesii T. & G. W. Kansas. From Prof Mudge.

ROSACEÆ.

Prunus, Plum Cherry.

213. P. Virginiana L., choke cherry. Law., Ell., Irv.
214. P. serotina Ehr., black cherry. Law.
215. P. Americana Marsh, wild plum. Law.
216. P. Chicasa Mx. Ell., Osw.: Dr. Newlon.
217. P. pumila L. Ell.

Rubus, Bramble.

218. R. villosus Ait., blackberry. Law.
219. R. Canadensis L., dewberry. Law., Osw.
220. R. occidentalis L., black raspberry. Law., Ell.

Geum, Avens.

221. G. album Gmel. Law.
222. G. Virginianum L. Law.

Fragaria, Strawberry.

223. †F. Illinoiensis. A species, or a variety of F. Virginiana, L. Law., Osw.

Potentilla, Cinque-foil.

224. P. Norvegica L. Law.
225. P. Canadensis L. Law.
—— P. Canadensis var. recta. Law. Very distinct; a species?
226. P. paradoxa, Nutt. Law.

Agrimonia, Agrimony.

227. A. Euptatoria L. Law.
228. A. parviflora Ait. Law.

Rosa, Rose.

229. R. setigera Mx., prairie rose (Michigan rose?). Law.
230. R. lucida Ehr., shining rose. Law.
231. R. blanda Ait., thornless rose. Law., Ell.
232. †R. Arkansana Porter. Law., Ell.; eight or ten flowers on one stem.

Amelanchier, Service Berry.

233. A. Canadensis T. & G. Osw.; also Atchison Co., Mrs. Jewell.

Cratægus, Thorn.

234. C. tomentosa L. Law.
235. C. Oxyacantha L. Osw.
236. C. Crus-galli L. Law.

Pyrus, Apple, Pear.

237. P. Ionensis. A species, or a variety of P. coronaria, L., crab-apple; leaves and young twigs very tomentose, fruit sometimes pyriform.
238. P. angustifolia Ait. Law., Snow.

SAXIFRAGACEÆ.

Henchera, Alum-root.

239. H. hispida Ph. Law.: Snow; Leav.: Wherrell.

Ribes, Currant, Gooseberry.

240. R. lacustre Poir. Law.
241. R. rotundifolium Mx. Law.
242. R. aureum Ph., flowering currant. Ell.

CRASSULACEÆ.

Sedom, Stone-crop.

243. S. pulchellum Mx. Osw.; also Humboldt: Snow.

Penthorum, Virginia Stone-crop.

244. P. sedoides L. Law., Osw.

HALORAGEÆ.

Myriophyllum, Water Milfoil.

245. M. verticillatum L. Ell.
246. M. scabratum Mx. Law., Ell.

LYTHRACEÆ.

Cuphea.

247. C. viscosissima Jacq. Osaw., Osw.

Lythrum, Loosestrife.

248. L. alatum Ph. Law., Osw.

Ammania.

249. A. latifolia L. Law.
—— A. latifolia. Var. pedicellata, pedicels 4 to 6 inches long; leaves narrower and less auriculate. A species?

ONAGRACEÆ.

Jussicaea.

250. J. repens L. Law.

Ænothera, Evening Primrose.

251. Œ. biennis L. Law., Ell.
252. Œ. sinuata L. Law., Osw.
253. Œ. pumila L. Law., Ell.
254. Œ. linearis Mx. Black Jack.
255. Œ. Missouriensis Sims. Law. Flowers very large; capsule-winged.
256. Œ. speciosa Nutt. Law., Sal. Flowers white, turning red.
257. †Œ. pinnatifida Nutt. Ell.
258. †Œ. albicaulis Nutt. Ell.
259. †Œ. triloba Nutt. Ell. Capsules large, glomerate, woody; plant stemless.
260. †Œ. lavendulæfolia Gr. Ell.
261. †Œ. rhombipetata. Solomon City Popenoe.
262. †Œ. serrulata Nutt. Ell.
263. †Œ. Fremontii. Rooks and Phillips Cos.: Popenoe.

Gaura.

264. G. biennis L. Law., Osw.
265. G. mollis Nutt. Law.
266. †G. parviflora Doug. Ell., Rooks Co.: Popenoe.
267. †G. coccinea Nutt. Ell.

Stenosiphon.

268. †S. virgatus Spach. Law., Ell., Irv.

Ludwigia, Bastard Loose-Strife.

269. L. alternifolia L. Osw.; also, Leavenworth: Wherrell.
270. L. alata Ell. Law.
271. L. palustris Ell. Law.

Circæa, Enchanter's Nightshade.

272. C. Lutetiana L. Law.

LOASACEÆ.

Mentzelia.

273. M. oligosperma Nutt. Law., Ell.
274. †M. ornata. W. Kansas: from Prof. Mudge.

PASSIFLORACEÆ.

Passiflora, Passion Flower.

275. P. lutea L. Osw.

CUCURBITACEÆ.

Echinocystis, Prickly Cucumber.

276. E. lobata T. & G. Law.

Sicyos, Single-seeded Cucumber.

277. S. angulatus L. Law.

Cucerbita, Pumpkin, etc.

278. C. perennis Gr. Law., one place, Sal.

CACTACEÆ.

Opuntia, Indian Fig.

279. O. vulgaris Mill. Law., Osaw.
280. O. Rafinesquii Eng. Law., Ell.
281. O. Missouriensis DC. Law., Ell.

Mamillaria.

282. †M. vivipara Haw. Ell.
284. †M. Nuttallii var. cæspitosa Eng. Ell.

UMBELLIFERÆ.

Sanicula, Sanicle.

284. S. Marilandica L. Law., Ell., Sal.
285. S. Canadensis L. Ell.

Eryngium.

286. E. yuccæfolium Mx. Law., Osaw. Pretends to be an endogen.
287. †E. Leavenworthii T. & G. Burl. and Franklin county; taken for a teasel.

Polytænia.

288. P. Nuttallii DC. Law.

Peucedanum, Parsnip, etc.

289. P. sativum Wood (Pastinaca L.), parsnip. Law.
290. †P. fœniculaceum Nutt. Law., Sal., Osw.; very early and common.
291. †P. nudicaule Nutt. Ell., Sal.

Osmorrhiza.

292. O. longistylis DC., sweet cicely. Osw.
293. O. brevistylis DC. Law.

Chærophyllum, Chervil.

294. C. procumbens Lam. Law.
295. C. Tainturieri Hook. and Arn. Law.: Snow.

Crytotænia, Honeywort.

296. C. Canadensis DC. Law.

Carum, Caraway, etc.

297. C. aureum Wood (Thaspium, Nutt.), Golden Alexanders. Law.

Pimpinella, Anise.

298. P. integerima B. & H. (Zizia, DC.) Law.; one place.

Æthusa, Fools' Parsley.

299. Æ. Cynapium L. Law.: Snow.

Sium.

300. S. lineare Mx. Law.
301. †S. angustifolium L. Ell.

Cicuta, Water Hemlock.

302. C. maculata L. Law.

Leptocaulis.

303. †L. echinaceus Nutt. Ell.

Discopleura, Bishop's Weed.

304. D. capillacea DC. Wabaunsee: from Mrs. S. M. Thomas.
305. D. Nuttallii DC. Osw.

CORNACEÆ.

Cornus, Dogwood.

306. C. asperifolia Mx. Law., Osw.
307. C. circinnata L. Law., Osw.
308. C. paniculata L'Her. Law.
300. †C. pubescens Nutt. Law., Ell., Osw.

CAPRIFOLIACEÆ.

Triosteum, Feverwort.

310. T. perfoliatum L. Law., Osw.

Symphoricarpus, Snowberry.

311. S. vulgaris Mx. Law., Osw.
312. S. occidentalis R. Br. Ell., W. K.: Popenoe.

Sambucus, Elder.

313. S. Canadensis L. Law.

Viburnum, Snowball, &c.

314. V. Lentago L., sweet viburnum. Law.: Snow.
315. V. prunifolium L., black haw. Osw.

RUBIACEÆ.

Galium, Bedstraw.

316. G. circæzans Mx. Law., Sal., Irv., Top.: Popenoe.
317. G. triflorum Mx. Law.
318. G. trifidum L. Law.
319. G. tinctorium Torr. Law.
320. G. concinnum Torr. Law.: Snow.
321. G. Aparine L. Law., Ell.
322. †G. asperrimum Gr. Ell.

Houstonia, Bluets.

324. H. minima Beck. Law.
325. H. purpurea L. Law.
326. H. angustifolia Mx. Ell., Sal., Irv.
327. H. tenuifolia Nutt. Sal., Irv.

Cephalanthus, Button-Bush.

328. C. occidentalis L. Law., Sal.

VALERIANACEÆ.

Fedia (Valerianella).

329. †F. Stenocarpa. Osw.

COMPOSITÆ.

Vernonia, Iron Wood.

330. V. fasciculata Mx. Law.
331. V. ovalifolia T. & G. Law. Common.
332. †V. Arkansana. E. Kansas. Hall.

Elephantopus, Elephant's Foot.

333. E. Carolinianus Willd. Osw.
334. E. tomentosus L. Osw.

Liatris, Button Snake-root.

335. L. squarrosa Willd. Blazing Star. Law., Sal., Osw.
336. L. cylindracea L. Law.: Saunders.
337. †L. punctata Hook. Law., Ell. Sandy spots.
—— L. punctata var. bracteosa, with long bracts among the heads.
338. L. pycnostachya M. Law., Osw.
339. L. scariosa L. Gay feather. Law., Sal., Osw. All the species prairie plants.

Kuhnia.

340. K. eupatorioides L. Law., Osw. Common.
341. †K. gracilis T. & G. Ell. Given in Porter and Coulter as a variety, but strikingly different. Both forms have the involucre striated like Brickellia—a point not mentioned in Wood nor Gray.

Brickellia.

342. B. cordifolia Ell. Law. Two specimens.
343. †B. grandiflora Nutt. Ellis.

Eupatorium, Boneset, &c.

344. E. ivæfolium L. Sal., Ell.
345. E. purpureum L. Law.
346. E. parviflorum. Ell., Osw., Irv., Burl.
347. E. altissimum L. Law.
348. E. perfoliatum L. Boneset. Law.; two places.
349. E. ageratoides L. Law., Sal., Osw.

Aster.

350. A. paludosus L. Osw.
351. A. sagittifolius Willd. Law.: Sanders.
352. A. undulatus L. Law., Osw. Has the sharp tooth of A. cordifolius, and the loose scales of A. sagittifolius.
353. A. azureus Ludl. Law., Osw.
354. A. sericeus Vent. Law.
355. A. lævis L. Law.
—— A. lævis. Var. lævigatus. Osw.
356. A. patens L. Osw.
357. A. Novæ-Angliæ L. Lam.
358. A. puniceus L., var. vimineus. Law.
359. A. carneus L. Law., Osw.
360. A. virgatus. Ell., Osw.
361. A. Novi-Belgii L. Law.
362. A. oblongifolius Nutt. Law.
363. A. Tradescanti L. Law.: Snow. Ell.
364. A. miser Ait. Law.
365. A. simplex Willd. Law., Osw.
366. A. tenuifolius L. Law.
367. A. ericoides L. Law.
368. A. multiflorus T. & G. Law., Ell., Osw.
—— A. multiflorus. A var. with flowers only terminal.
369. †A. Nuttallii T. & G. (Fendleri). Ellis, Burl. Popenoe.

Townsendia.

370. †T. sericea Hook. Ellis.

Manchæranthera.

371. †M. tanacetifolia Nees. Ellis.

Diplopappus, Double-bristled Aster.

372. †D. ericoides T. & G. Ellis.

Erigeron, Fleabane.

373. E. Canadense L. Law.
374. E. divaricatum Mx. Law.
376. E. bellidifolium Muhl. Law.
377. E. Philadelphicum L. Law.
378. E. annuum Pers. Law., Irv.
379. E. strigosum L. Law.
—— E. strigosum var. integrifolium. Osw.

Boltonia.

380. B. glastifolia L'Her. Law., Osw.

Gutierrezia.

381. †G. Euthamiæ T. & G. Ellis.

Amphiathyris.

382. †A. dracunculoides DC. Paola, S. Kansas: Hall.
—— †A. dracunculoides var. with branches irregular—not umbel-like. Osw.

Solidago, Golden Rod.

383. S. squarrosa Muhl. Osw.
384. S. petiolaris Ait. Law.
—— S. petiolaris var. suaveolens. Law. A species?
385. S. Virga-aurea L. Rooks Co.: Popenoe.
386. S. speciosa Nutt. Law.; variable.
387. S. puberula Nutt. Law.: Snow.
388. S. Missouriensis Nutt. Law., Osw.
389. S. giganteus Ait. Law., Ell.
390. S. Canadensis L. Law.
391. S. ulmifolia Muhl. Law.
392. S. rigida L. Law., Ell., Osw.
393. †S. asperrima. Ellis.
394. S. lanceolata Ait. Law., Irv.
395. S. tenuifolia Ph. Law., Irv.

Aplopappus (Prinopsis).

396. †A. spinulosus D. C. Ellis, Sal.
397. †A. ciliatus. Law., Ell., Sal.

Grindelia.

398. †G. squarrosa Dunal. Law.
399. †G. lanceolata. Osw., Law.; once.

Heterotheca.

400. H. scabra DC. Law., Ell.

Chrysopsis.

401. C. villosa Ph. Ellis, W. Kan.: Popenoe.
—— C. villosa var. hispida. Ell.

Diaperia.

402. †D. prolifera Nutt. Ell.

Polymnia, Leaf Cup.

404. P. Uvedalia L. Osw.

Eclipta.

405. E. alba L. Law.

Silphium, Resin Wood, etc.

406. S. laciniatum L., polar plant. Law.
407. S. integrifolium Mx. Law.
408. S. lævigatum. Ell., Law.
409. †S. asperrimum. Law.: Snow.
410. S. perfoliatum L., cup plant. Law.

Parthenium.

411. P. integrifolium L. Law.; seen once.

Iva, Marsh Elder.

412. I. ciliata Willd. Law.
413. †I. xanthiifolia Ar. Ellis.

Ambrosia, Hodweed, etc.

414. A. trifida L. Law.; leaves sometimes 5-tubed.
415. A. artemisiæfolia L., hog-weed or Roman wormwood. Law.
416. A. psilostocrya DC. Ellis, Osw.
417. A. bidentata Mx. Osw.

Xantrium, Clot-bur.

418. X. strumarium L. Law.

Heliopsis, Ox-eye.

419. H. lævis Pers. Law.; rare.
—— H. lævis var. scaba. Law.; common.

Ecrinacea, Purple Cone-flower.

420. E. purpurea Moench. Miami Co.
421. E. angustifolia DC. Law.
422. †E. atrorubens Nutt. Law.

Rudbeckia, Cone-flower.

423. R. laciniata L. Law., Irv.
424. R. subtomentosa Ph. Law.
425. R. triloba L. Law.
426. R. hirta L. Law.: Snow.

Dracopsis.

427. †D. amplexicaulis Cass. Osw.

Lepachys.

428. L. pinnata T. & G. Law., Osw., Irv.
429. †L. columnaris Wood. Ellis, Irv.
—— L. columnaris var. pulcherrima. Law.: Saunders.

Helianthus, Sunflower.

430. H. rigidus Desf. Law.
431. H. atrorubens L. Law.
432. †H. petiolaris Nutt. Ellis.
433. †H. lenticularis Dougl. Law.; very common.
434. †H. orgyalis DC. Paola, Osw.; lately come to Law.; rocky places; leaves long and narrow.
435. †H. Maximiliani. Law.; allied to H. giganteus.
43 . H. tomentosus Mx. Law.
437. H. grosse-serratus Martins. Law.; common.
438. H. tuberosus L. Law.; see introduction.
439. H. lætiflorus Pers. Law.
440. H. mollis Lam. Law., Osw.
441. H. decapetalus L. Law., Ell.
442. H. trachelifolius Willd. Law., Osw. Have observed that this species and others which have leaves alternate above, have them all opposite, if they grow only about half the usual height.
443. H. doronicoides Lam. Law. (See in-

troduction.)
444. H. strumosus L. Law.
445. H. hirsutus Raf. Law., Osw. Two more forms that appear distinct with very scabrous, roundish leaves.

Actinomeris.

446. A. helianthoides Nutt. Osw., Irv.
447. A. squarrosa Nutt. Law., Osw.

Thelesperma.

448. †T. gracile Gr. Hutchinson: Popenoe.

Coreopsis, Tick-seed.

449. C. tinctoria Nutt. S. Kan.: Hall.
450. C. palmata Nutt. Law.
451. C. delphinifolia Lam. Law.
452. C. aristosa Mx. (involucrata, Nutt.) Law.; common.
453. †C. cardaminifolia DC. Osw., Sal.

Bidens, Bur Marigold.

454. B. bipinnata L. Spanish Needles. Osw.
455. B. frondosa L. Beggarticks, Cuckold. Law.
456. B. connata Willd. Law.
457. B. cernua L. Law.
458. B. chrysanthemoides L. Law.

Verbesma, Crown-Beard.

459. V. Virginica L. Law., Osw.
460. V. sinuata Ell. Osw.

Dysodia, False Dog-fennel.

461. *D. chrysanthemoides Lagasca. Law.; streets.

Gaillardia.

462. G. lanceolata Mx. Solomon City: Popenoe.
463. G. pulchella Doug. Ellis, Dodge: Popenoe.

Bahia.

464. †B. —— New species, so Mr. Wood thinks. Ellis. Much like Matricaria.

Actinella.

465. †A. acaulis L. Dodge: Popenoe.
466. †A. scaposa Nutt. Ellis: L'Her.

Hymenopappus.

467. H. scabiosæus. Clay Co.: Popenoe.
468. †H. tenuifolius Ph. Ellis, Sal.

Helenium.

469. H. autumnale L. Law.
470. H. tenuifolium Nutt. Osw.
471. H. quadridentatum Labill. Law., Osw.
472. †H. tanacetifolium. W. Kansas: Popenoe.

Anthemis, Camomile, etc.

473. *A. cotula L., Mayweed. Law., streets.

Achillea, Yarrow.

474. A. millefolium L. Law.

Artemisia, Wormwood.

475. A. frigida Nutt. W. Kan.: Popenoe.
476. A. Ludoviciana Nutt. Law.
477. A. vulgaris L. Law., Ell.
478. A. biennis Willd. Law., Irv.
479. †A. dracunculoides Ph. Law., Ellis, Sal.
480. †A. filiformis Torr. Ellis.
481. †A. Carruthii sic vult Mr. Wood, nov. sp. Erect, simple, clothed all over in a white tomentum. Leaves pinnately parted, with linear segments, the lower bipinnately, with leafy axillary tufts, all close-pressed, 1′ and less long. Heads oblong, small, 1″, 7-lined flowered, homogamous, all condensed in a narrow, spike-like panicle. Plant, 1-2 feet.

Gnaphalium, Cudweed.

482. G. polycephalum Mx. Osw., Law.: Snow.

Antennaria, Everlasting.

483. A. dioica Gaert., mouse-ear everlasting (plantaginifolia). Law.

Erechthites, Fire-Weed.

484. E. hieracifolius Raf. Law.

Cucalia, Tassel-Flower, etc.

485. C. atriplicifolia L. Law.
486. C. tuberosa Nutt. Law.

Senecio, Groundsel.

488. S. aureus L. Law., Ell.
489. S. anonymus Wood. Ellis.
490. †S. longilobus Benth. Ellis.
491. S. lobatus Pers. Osw.

Cirsium, Thistle.

492. C. undulatum Spr. Ellis, W. Kan.: Popenoe.
493. C. altissimum Spr. Law., Irv.
494. C. Pitcheri T. & G. Irv.
495. C. Virginanum Mx. Law.

Lappa, Burdock.

496. *L. major Gaert. Law.

Krigia, Dwarf Dandelion.

497. K. Virginica Willd. Law.: Snow. One specimen. Top.: Popenoe. Think I have seen it.

Cynthia.

498. C. Dandelion DC. Osw.

Hieracium, Hawkweed.

499. H. longipilum Torr. Law., Osw.
500. H. Gronovii L. Law.: Snow.
501. H. paniculatum L. Law.: Snow.

Nabalus, Drop-Flower.

502. N. asper T. & G. Law., Osw.
503. N. racemosus Hook. Law.

Lygodesmia.

504. †L. juncea Don. Sal., W. Kan.: Popenoe.

Troximon.

505. T. cuspidatum Nutt. Law.

Taraxacum, Dandelion.

506. *T. Dens-leonis Less. Law.

Lactuca, Lettuce.

507. L. Canadensis L., (elongata.) Law. Very variable.

Mulgedium.

508. M. pulchellum Nutt. W. Kan.: Popenoe.

Sonchus, Sow Thistle.

509. S. asper Vill. Law. Variable.

Engelmannia.

510. †E. pinnatifida T. & G. Russell Co.: Popenoe. Should be after Silphium.

LOBELIACEÆ.

Lobelia.

511. L. cardinalis L. Osaw., Ell. Rare.
512. L. syphilitica L. Law., Osw. Teeth of L. glandulosa.
513. L. leptostachys A. DC. Law., Osw.
514. L. spicata Lam. Top.: Popenoe. Rare.

CAMPANULACEÆ.

Campanula.

515. C. Americana L. Law., Osw.

Specularia.

516. S. perfoliata Lam. Law., Ell., Osw.
517. †S. leptocarpa Nutt. Ell., Osw., Law.: Snow. Riley Co.: Popenoe.

ERICACEÆ.

Gay-Lussacia, Huckleberry.

518. G. resinosa T. & G. Baxter Springs: Mr. N. D. Ingraham, nurseryman.

Monotropa, Indian Pipe.

519. M. uniflora L. Vinland, Douglas Co.: Miss S. Cutter.

AQUIFOLIACEÆ.

Prinos, Winterberry.

520. P. glaber Gray. Osw.

EBENACEÆ.

Diospyros, Persimmon.

521. D. Virginiana L. Law., Osw.

PRIMULACEÆ.

Androsace.

522. A. occidentalis Ph. Law., Ell.
523. A. filiformis Retz. Ell.

Lysimachia, Loosestrife.

524. L. hybrida Mx. Law., Osw.
525. L. ciliata L. Law., Osw.

PLANTAGINACEÆ.

Plantago, Plantain.

526. *P. major L. Law.
527. P. lanceolata L. Law.; one place.
528. P. aristata Mx. Law.
529. P. Virginica L. Law.
530. P. gnaphalioides Gr. Ell.
531. P. pusilla Nutt. Ell., Sal.

LENTIBULACEÆ.

Utricularia, Bladderwort.

532. U. vulgaris L. Law., Ell.

OROBANCHACEÆ.

Aphyllon, Naked Broom-rape.

533. A. uniflora T. & G. Law.: Snow.
534. A. fasciculata T. & G. Irv.: Mrs. Jewell.

Phelipea, Broom-rape.

535. P. Ludoviciana Don. Law. One plant; Burlington. Also from Marshall county to Prof. Snow, by W. J. McLaughlin.

PEDALIACEÆ.

Martynia, Unicorn Plant.

536. M. proboscidea Glox. Law. Near gardens.

SCROPHULARIACEÆ.

Verbascum, Mullein.

537. *V. Thapsus L. Law.
538. *V. blattaria L. Law. One plant.

Linaria, Toad-flax.

539. *L. vulgaris Mill. Law. Near a garden.

Scrophularia, Figwort.

540. S. nodosa L. Law.

Pentstemon, Beard-tongue.

541. P. grandiflorus Fras. Russell county: Snow; Law.: Sanders.
542. P. pubescens Soland. Law.
543. P. gracilis Nutt. Law., Osw., Burl.
544. †P. cobæa Nutt. Law. Fine.
545. †P. albidus Nutt. Ell.
546. †P. tubiflorus. Law.: Snow.

Collinsia, Innocence.

547. C. verna Nutt. Osw.

Mimulus, Monkey-flower.

548. M. ringens L. Law.: Snow.
549. M. alatus Ait. Law., Osw.
550. M. Jamesii Torr. Ell., Irv. "The hands are Esau's, but the voice is Jacob's." Leaves agree with M. Jamesii; the flowers with M. robellus. Quite a mimic.

Conobea.

551. C. multifida Benth. Law., Osaw., Osw.

Herpestis.

552. H. rotundifolia Ph. Law. Flowers white.

Ilysanthus.

553. I. gratioloides Benth. Law.

Veronica.

554. V. Virginica L. Culver's Physic. Law.
555. V. Americana Schw. Irv.: Mrs. Jewell.
556. V. peregrina L. Law., Ell.
557. V. anagallis L. Irv.

Buchnera, Blue-hearts.

558. B. Americana L. Law., Osw., Burl.
559. †B. elongata Swz. Osw.

Seymeria.

560. S. macrophylla Nutt. Near Baldwin

Gerardia.

561. G. auriculata Mx. Law., Osw., Top.: Popenoe.
562. G. aspera Doug. Law., Salina, Osw.
563. G. purpurea L. Law., Ell., Sal., Osw.
564. G. tenuifolia Vahl. Law., Burl.

Castilleia, Painted Cup.

565. C. sessiliflora Ph. Ell., Salina.

Pedicularis, Lousewort.

566. P. Canadensis L. Law.

ACANTHACEÆ.

Ruellia.

567. R. strepens Nees. Law., Osw.
568. R. ciliosa Nees. Law., Sal., Osw., Irv.

Dicliptera.

569. D. brachiata Spr. Law., Osw.

Dianthera.

570. D. Americana L. Law., Burl.

VERBENACEÆ.

Verbena, Vervain.

571. V. angustifolia Mx. Law., Osw.
572. V. hastata L. Law., Osw.
573. V. urticæfolia L. Law.
574. V. stricta Vent. Law.
575. V. bracteosa Mx. Law., Ell.
576. V. spuria L. Law.; one place.
577. V. Aubletia L. Law.

Lippia, Fog-fruit.

578. L. lanceolata Ph. (nodiflora). Law., Ell., Osw.
579. †L. cuneifolia T. & G. Ell.

Phryma, Lopseed.

580. P. leptostachya L. Law., Osw.

LABIATÆ.

Teucrium, Germander.

581. T. Canadense L. Law., Ell., Osw.
—— T. Canadense var. bracteosa. Law.

Isanthus, False Pennyroyal.

582. L. cæruleus Mx. Law.

Mentha, Mint.

583. M. Canadensis L. Law.

Lycopus, Water Hoarhound.

584. L. Europæus L. Law., Osw.
585. L. Virginicus L. Irv.: Mrs. Jewell.

Hedeoma, Pennyroyal.

586. H. hispida Ph. Law., Ell.
587. †H. Drummondi Benth. Ell., Osborne: Popenoe.

Pycnanthemum, Basil.

588. P. pilosum Nutt. Law.
589. P. lanceolatum Ph. Law.
590. P. linifolium Ph. Law., Osw.

Salvia, Sage.

591. †S. Pitcheri Torr. Law., Ell., Osw.
592. †S. lanceolata Willd. (trichostemmoides). Law., Ell.

Monarda, Mountain Mint.

593. M. fistulosa L. Law.
594. M. Bradburiana Nutt. W. Kan.: Popenoe.
595. M. punctata L. Osw.
596. †M. aristata Nutt. Cloud Co.: Popenoe.

Blephilia.

597. B. ciliata Raf. Baldwin.
598. B. hirsuta Benth. Baldwin.

Lophanthus, Hedge Hyssop.

599. L. nepetoides Benth. Law., Osw.

Nepeta.

600. *N. Cataria L., catmint. Law.
601. *N. Glechoma Benth., gill-over-the-ground. Law.

Brunella, Self-heal.

602. B. vulgaris L. Law., Osw.

Scutellaria, Scullcap.

603. S. lateriflora L. Marshall Co.: to Prof. Snow by Mrs. S. D. Mauk.
604. S. parvula Mx. Law.
605. †S. Wrightii Gr. Ell., Osborne: Popenoe.

Physostegia, Lion Heart.

606. P. Virginiana Benth. Law.

Stachys, Hedge Nettle.

607. S. glabra Riddell. Law., Irv.
608. S. palustris L. Law.
609. S. sylvatica Nutt. Law.: Snow; one specimen.

Leonurus, Motherwort.

610. *L. Cardiacus L. Law.

Marrubium, Hoarhound.

611. *M. vulgare L. Law., Osw.

BORRAGINACEÆ.

Onosmodium.

612. O. Virginicum Alph. DeC. Law., Ell.
613. O. Carolinianum DC. Law.
614. O. molle Mx. Law., common. Osw.

Lithospermum, Gromwell.

615. L. angustifolium Mx. Law., Ell.
616. L. canescens Lehm. Puccoon, Indian paint. Law.
617. L. hirtum Lehm. Law.: Snow.
618. L. longiflorum Spreng. Law., Ell. Because an intermediate has been found between Nos. 615 and 618, it is proposed to regard them as one species. Was it ever known that a species varied in its blossoms from white to yellow, or v. v.?

Echinospermum.

610. E. lappula Lehm. Ell., Law.: Snow. Irv.: Mrs. Jewell.
620. †E. Redowskii Lehm. Ell.

Cynoglossum, Hound's Tongue.

621. *C. officinale L. Law. One place.
622. C. Morrisoni DC., beggar-ticks. Law.

Eritrichium.

623. †E. crassisepalum Torr. Ell.

HYDROPHYLLACEÆ.

Hydrophyllum, Water Leaf.

624. H. Virginicum L. Law.

Ellisia.

625. E. Nyctelea L. Law., Ell., Osw. E. Nyctelea. Dwarf specimens, two inches high. Ell.

Phacelia.

626. †P. —— Species under consideration.

POLEMONIACEÆ.

Phlox.

627. P. pilsoa L. Law., Osaw.
628. P. divaricata L., var. Laphamii. Law., Osw.
629. P. Carolina L. Irv.: Mrs. Jewell.

Polomonium.

630. P. reptans L., Jacob's ladder. Reported to Prof. Snow.

CONVOLULACEÆ.

Quamoclit, Cypress Vine.

631. Q. coccinea Mœnch. Law.

Pharbitis, Morning- Glory.

632. *P. purpurea Lam. Purple morning-glory. Law.
633. *P. Nil Chois. Blue morning-glory. Law.

Ipomæa.

635. I. lacunosa L. Law.
635. I. pandurata Meyer, wild potato. Law., Osw.
636. †I. leptophylla Torr. Ell., Sal. Convolvulus, Bind-Weed.
637. C. arvensis L. Top.: Popenoe.

Calystegia.

638. C. spithamæa Br. Law., Ell.
639. C. sepium Br. Law.
640. C. Catesbiana Ph. Rll., Irv.

Bonammia, (Stylisma.)

641. †B. Pickeringii. Solomon City.: Popenoe.

Evolvulus.

642. †E. argenteus Ph. Ell.

Cuscuta, Dodder.

643. C. glomerata Chois. Law.; common.
644. C. compacta Juss. Law.: Snow.
645. C. tenuiflora Eng. Ell., Irv., Law.: Saunders.
646. C. decora Chois. Law.: Snow.
647. C. chlorocarpa Eng. Law.; one place.
648. C. arvensis Eng., var pentagona. Irv.
649. C. Gronovii Willd. Law.

SOLANACEÆ.

Solanum, Potato, etc.

650. S. nigrum L., black nightshade. Law.
651. S. Carolinense L., horse nettle. Law., Sal.
652. S. Dulcamara L., bitter-sweet. Osw.: Dr. Newlon. Atchison county: Miss Randolph.
653. *S. rostratum Dun. Law., Osw.

Physalis, Ground Cherry.

654. P. viscosa L. Law. Annual.
655. P. nyctaginea Dun. Law., Sal. Annual.
656. P. Pennsylvanica L. Law., Sal., Osw. Perennial.
657. P. lanecolata Mx. Law., Sal. Perennial.
658. P. Philadelphica. Law., Top.: Popenoe. Annual.
659. P. pubescens L. Law. Perennial.
660. †P. rhomboidea C. Law., Sal. Perennial.
661. †P. mollis. Phillips Co.: Popenoe. For remarks on the Physalids, see introduction.

Withania.

662. *W. sordida. Ellis.

Datura, Jimson-weed.

663. *D. stramonium L. Law.

GENTIANACEÆ.

Sabbatia, American Century.

664. S. gracilis Salisb., or S. stellaris, Ph., or both. Osw. Pretty.

Gentiana, Gentian.

665. G. alba Muhl. Law.
666. G. Andrewsii Griseb. Law.
667. G. Saponaria L. Law.
668. G. puberula Mx. Law.

APOCYNACEÆ.

Apocynum, Dogbane, etc.

669. A. androsæmifolium L. Ell., Osw.
670. A. cannabinum L. Law.

ASCLEPIADACEÆ.

Asclepias, Milkweed.

671. A. Cornuti Decaisne. Law.
672. A. Sullivantii Eng. Law.
673. A. purpurascens L. Law., Sal., Osw.
674. A. ovalifolia Decaisne (Vaseyi, T. & G.) Law., Ell., Sal.
675. A. obtusifolia Mx. Law.
676. A. speciosa Torr. Hutchinson: Popenoe.
677. A. Jamesii Torr. Extreme W. Kan.: Popenoe.
678. A. Meadii Torr. Law.: Snow. In 1873, I found several specimens agreeing nearly with A. Meadii, but they had umbels nodding. Have looked in vain for them each year since.
679. A. incarnata L. Law., Irv.
680. A. tuberosa L. Law.
681. A. verticillata Ell. Law., Ell., Osw.

Acerates, Hornless Milkweed.

682. A. viridiflora Ell. Law., Ell., Sal.
683. A. monocephala Lapham. (A. lanuginosa.) Law.: Snow. Topeka: Popenoe.
684. A. longifolia Ell. Law., Sal.
685. †A. angustifolia Decaisne. Law., Ell.
686. A. paniculata Nutt. Law., Sal.
687. †A. auriculata Eng. Ell.
688. A. ———. Stem simple, one foot; leaves petiolate, lanceolate, obtuse, 2′ by ½′; umbel terminal sessile; flowers like A. paniculata. Ell.

Ensienia.

689. E. albida Nutt. Law., Irv.

OLEACEÆ.

Fraxinus, Ash.

690. F. Americana L. White Ash. Law.
691. F. viridis Mx. Green Ash. Law., Osw.

ARISTOLOCHIACEÆ.

Aristolochia, Birthwirt.

692. A. Sipho L., Her. Osw.

NYCTAGINACEÆ.

Oxybaphus.

693. O. nyctagineus Sweet. Law., Osw.
694. O. angustifolius Sweet. Law., Sal.
695. O. linearis Ph. Law., Ell., Burl. I find no intermediates between the last two.
696. O. albidus Sweet. Law.: Snow.

POLYGONACEÆ.

Eriogonum.

697. †E. annuum Nutt. Ell.; also, W. Kansas: Popenoe.

Rumex, Dock Sorrel.

698. *R. crispus L. Yellow Dock. Law.
699. R. altissimus Wood. Peach-leaved Dock. Law.
700. R. verticillatus L. Irv.: Mrs. Jewell.
701. *R. acetosella L. Sheep Sorrel. Law.
702. †R. venosus Ph. Ell.

Polygonum, Knot Grass, etc.

703. *P. aviculare L., knot grass. Law., Ell.
704. P. erectum L. Law.
705. P. tenue Mx. Law.
706. P. maritimum L. Law.
707. P. ramosissimum Mx. Law., Osw.
708. P. hydropiperoides Mx., mild water-pepper. Law.
709. P. acre H. B. K., water smartweed. Law.
710. P. Hydropiper L., water-pepper. Law.
711. P. Persicaria L., lady's thumb. Law.
712. P. Pennsylvanicum L. Law., Ell.
713. P. incarnatum Ell. Law.
—— P. incarnatum var. with seeds in shape of a quarter of an apple, with the core cut out. Law.
714. P. amphibium L. Law., Osw.
715. P. Virginicum L. Law., Osw.
716. P. Convolvulus L., knot bind-weed. Law., Ell.
717. P. dumetorum L., hedge bind-weed. Law., Ell., Osw.

PHYTOLACCACEÆ.

Phytolacca, Poke.

718. P. decandra L. Law.

CHENOPODIACEÆ.

Cycloloma.

719. C. platyphyllum Moquin. Law., S. W. Kansas.

Chenopodium, Pigweed, etc.

720. C. hybridum L. Law.
721. C. Boscianum Gr. Law.
722. C. album L., pigweed. Law.
723. C. ambrosioides L., Mexican tea. Law.
724. C. anthelminticum Gr., wormseed. Osw.

AMARANTACEÆ.

Amarantus, Amaranth.

725. A. paniculatus L. Law.
726. A. retroflexus L. Law.
—— A. retroflexus var. giganteus. Law.
727. A. chlorostachys Willd. Law.
728. A. hybridus L. Law.
729. A. albus L. Law.
730. A. blitum. Law.; see introduction.

Amblogyne.

731. †A. Torreyi Gr. Law.

Montelia.

732. M. tamariscina Gr. Law.

Frælichia.

733. F. floridana Moq. Osw.; also from Wabunsee: Mrs. S. M. Thomas. Solomon City: Popenoe.

LAURACEÆ.

Sassafras, Sassafras.

734. S. officinale Nees. Cherokee Co.; from Mr. T. E. Barnard.

Benzoin, Spice Brush.

735. B. odoriferum Nees. Osw.

LORANTHACEÆ.

Phoradendron, Mistletoe.

736. P. flavescens Nutt. Osw.: Dr. Newlon.

SANTALACEÆ.

Comandra, Bastard Toad-flax.

737. C. umbellata Nutt. Law.

EUPHORBIACEÆ.

Euphorbia, Spurge.

738. E. marginata Ph. Law., Ell.
739. E. corollata L. Law.
740. E. Curtisii Eng. Law., Ell., Osw.
741. E. dictyosperma Eng. Law., Sal.
742. E. obtusata Ph. Law., Irv.
743. E. heterophylla Mx. Law.
744. E. dentata Mx. Law., Ell., Sal.
745. E. hypericifolia L. Law., Osw.
746. E. glyptosperma Eng. Law., Osw., Phillips Co.: Popenoe.
747. E. maculata L. Law.
748. E. humistrata Eng. Law.
749. E. cordifolia Ell. Law.
750. E. serpens H. B. K. Law.
751. †E. hexagona Nutt. Law., Ell., Top.: Popenoe.
752. †E. ———. Seed oblong, junk-bottleate at one end. Osw.

Tragia.

753. T. urticæfolia Mx. Law., Sal.
754. T. ramosa Tarr. Osborne City: Popenoe.

Acalpyha, Three-seeded Mercury.

755. A. Virginica L. Law.
756. A. gracilens Gr. Law., Osw. The two appear quite distinct.

Croton.

757. C. monanthogynus Mx. Law., Ells., Osw.
758. C. capitatus Mx. Law., Osw., Irv.
759. †C. Texensis Mull. (C. muricatus, Nutt.) Ell., Russell Co.: Popenoe.

URTICAEÆ.

760. U. Americana L. White Elm. Law.
761. U. fulva Mich. Slippery Elm. Law.

Cellis, Hackberry.

762. C. occidentalis L. Law.

Maclura, Osage Orange.

763. *M. aurantiaca Nutt. Law.

Morus, Mulberry.

764. M. rubra L. Law.

Urtica, Nettle.

765. U. procera Willd. Law.
766. U. dioica L. Law.
767. U. urens L. Law.

Laportea, Wood-nettle.

768. L. Canadensis Gaudich. Law.

Pilea, Richweed.

769. P. pumila Gr. Law.

Parietaria, Pellitory.

770. P. Pennsylvanica Muhl. Law., Ell., Irv.

Humulus, Hop.

771. H. Lupulus L. Law.

CALLITRICHACEÆ.

Callitriche.

773. C. verna L. Law., Ell.
774. C. autumnalis L. Ell., Irv.

CERATOPHYLLACEÆ.

Ceratophyllum, Hornwort.

775. C. demersum L. Law.

PLANTANACEÆ.

Plantanus, Button-Ball Sycamore.

776. P. occidentalis L. Law.

JUGLANDACEÆ.

Juglans.

777. J. nigra L., black walnut. Law.
778. J. cinerea L., Butternut. Lyon Co.: Popenoe.

Carya, Hickory.

779. C. olivæformis Nutt, pecan. Osw., Humboldt.
780. C. amara Nutt, bitter-nut. Law.
781. C. aquatica Nutt, water bitter-nut. Law.
782. C. alba Nutt, shagbark. Law.
783. C. sulcata Nutt, shellbark. Law.
784. C. porcina Nutt pig-nut. Osaw.
785. C. microcarpa Nutt, bark black. Osw.; also a sp. or var. with leaflets strangely cordate; fruit not seen.

CUPULIFERÆ.

Quercus, Oak.

786. Q. imbricaria Mx., shingle oak. Law.; one tree.
787. Q. laurifolia Mx. Near Westport, Mo., abundant; leaves on in February; black bark.
788. Q. nigra L., black-jack. Law.; Sandy spots.
789. Q. rubra L., red oak. Law.
790. Q. palustris Mx., pin oak. Osw.
791. Q. falcata L., Spanish oak. Law.
792. Q. coccinea Wang., scarlet oak. Law.; not quite sure.
793. Q. tinctoria Bartram, yellow-bark oak. Law.
794. Q. alba L., white oak. Baldwin; three places; in one sinuses of leaves very deep.
795. Q. obtusiloba Mx., (stellata), iron oak, post oak. Osw.
796. Q. macrocarpa Mx., bur oak. Law. and elsewhere, on bottoms.
—— Q. macrocarpa Mx. Var. or species. Leaves shorter, with fewer sinuses. Acorn more covered. Scales of cup near the fringe, tuberculate and pointed. Q. olivæformis. Law.
797. Q. Prinos L. Swamp Chestnut Oak. Law., Osaw.
798. Q. bicolor Willd. Swamp White Oak. Law., Osaw.
799. Q. castanea Muhl. Chestnut Oak. Law.
800. Q. prinoides Willd. Chinquepin Oak —four feet high. Law.
801. †Q. —— Leaves cruciform, with triangular lobes. Scales large, nearly covered, nut pointed. One tree near Tonganoxie.

Corylus, Hazel.

802. C. Americana Walt. Law.

Ostrya, Lever-wood.

803. O. Virginiaca Willd. Law. Two places. Reported from Fort Leavenworth: F. Van Vliet. Atchison county: Miss Randolph.

BETULACEÆ.

Betula, Birch.

804. B. lenta L. Osw.

SALICACEÆ.

Salix, Willow.

805. S. tristis Ait. Law.
806. S. humilis Marsh. Law.: Snow.
808. S. longifolia Muhl. Law.: Snow.
809. S. nigra Marsh. Law.: Snow.
810. S. cordata Muhl. Law.: Snow.

Populus, Poplar.

812. P. canadensis Desf. (monilifera, Ait.) Law. and elsewhere.

CONIFERÆ.

Juniperus, Red Cedar.

813. J. Virginiana L. Anderson county. Rare in the east; said to be common in the west.

ARACEÆ.

Arisæma, Indian Turnip.

814. A. triphyllum Torr. Jack-in-the-Pulpit. Law.
815. A. Dracontium Schott, green dragon. Law.

LEMNACEÆ.

Lemna, Duckmeat.

816. L. perpusilla Torr. Law.
817. L. polyrrhiza L. W. Kan.: Popenoe.

TYPHACEÆ.

Typha, Cat-tail.

818. T. latifolia L. Law.

Sparganium, Bur Reed.

819. S. eurycarpum Eng. Law.

NAIADACEÆ.

Naias, Water Nymph.

820. N. flexilis Rostk. Law.

Zannichellia, Horn Pondweed.

821. Z. palustris L. Ell.

Potamogeton, Pondweed.

822. P. natans L. Law., Ell.
823. P. pectinatus L. Law.
824. P. —— Near P. amplexifolius. Ell.

ALISMACEÆ.

Alisma, Water Plantain.

825. A. Plantago L. Law.

Echinodorus.

826. E. rostratus Eng. Law.

Sagittaria, Arrow-head.

827. S. variabilis Eng. Law., Ell., Osw. Many varieties.

HYDROCHARIDACEÆ.

Anacharis, Ditch Moss.

828. A. Canadensis Planchon. Law.: Saunders.

ORCHIDACEÆ.

Cypriedium, Lady's Slipper.

829. C. parviflorum Salisb. Law.: Snow.

Orchis, Orchis.

830. O. leucophæa Nutt. Law.

Spiranthes, Ladies' Tresses.

831. S. cernua Rich. Osaw.
832. S. graminea var. Walterii, Lind. Burl.; from Mr. H. H. Wright.
833. S. gracilis Bigel. Law.

Pogonia.

834. P. pendula Lind. Top.: Popenoe. Rare.

AMARYLLIDACEÆ.

Hypoxis, Star-Grass.

835. H. erecta L. Law.
836. H. filifolia Ell. Top.: Popenoe. Rare.

HÆMODORACEÆ.

Lachnanthes (Dilotris), Red-Root.

837. L. tinctoria Ell. Osw.: Dr. Newlon.

IRIDACEÆ.

Sisyrinchium, Blue-Eyed Grass.

839. S. Bemudiana L. Law.

DIOSCOREACEÆ.

Dioscorea, Yam.

840. D. villosa L. Osw.

SMILACEÆ.

Smilax, Greenbrier.

841. S. rotundifolia L. Osaw., Sal.
842. S. pseudo-China L. Sal.
843. S. tamnoides L. Osw.
844. S. peduncularis Muhl. Law.
845. S. tamnifolia Mx. Law.

LILIACEÆ.

Erythronium.

846. E. albidum Nutt. Law.

Lilium, Lily.

847. L. Carolinianum Mx. Law.; rare.

Scilla, Squill.

848. S. esculenta Ker. (Fraseri, Gr.), wild hyacinth. Law., Osw., Wabaunsee county.

Allium, Onion.

849. A. cernuum Roth. Osw.; stamens exsert, but umbels not nodding.
850. A. Canadense Kalm. Law.
851. A. striatum Jacq. Law., Burl.
852. A. unitabile Mx. Law., Osw.
853. †A. reticulatum Fraser. Ell., Osw.

Yucça.

854. †Y. angustifolia Ph. Sal.

Polygonatum, Solomon's Seal.

855. P. biflorum Ell. Law.
856. P. giganteum Dietrich. Law.

Smilacina.

857. S. stellata Desf. Law.

MELANTHACEÆ.

Melanthium.

858. M. Virginicum L. Law.

PONTEDERIACEÆ

Pontederia, Pickerel Weed.

859. P. cordata L. Burl.

Heteranthera.

860. H. reniformis Ruiz. and pavon. Law.; flowers 8-12, violet-blue; leaves large; sinus at base narrow; common.
861. H. limosa Vahl. Law.; common.

Schollera.

862. S. graminea Willd. Ell.

JUNCACEÆ.

Juncus, Rush.

863. J. scirpoides Lam., var. echinatus. Law.
864. J. nodosus L., var. megacephalus. Law.
865. J. stygius L. Law.
866. J. bufonius L., toad rush. Law.
867. J. tenuis Willd. Law.

COMMELYNACEÆ.

Commelyna.

868. C. Virginica L. Law.

Tradescantia, Spiderwort.

869. T. Virginica L. Law., Sal. Glaucous, branching, flowering all summer; separate; smooth.
870. T. pilosa Lehm. Law., Ell., Sal., Irv. Green, flowering only till June; pilous only on the sepals, pedicels and base of the bracts; a var. from Salina, with leaves pilose.

CYPERACEÆ.

Cyperus, Galingale.

871. C. erythorhizos Muhl. Law.: Snow.
872. C. phymatodes Muhl. Law.
873. C. Michauxianus Schultes. Law.: Saunders.
874. C. strigosus L. Law., Osw.
875. C. Schweinitzii Torr. Law.
876. †C. spiculatus Wood, n. sp. Calm, tall, glabrous, triquetrous; involucre of about 7 very long, flat leaves, rough-edged, umbel 8-rayed, rays very unequal, each having from 3 to 7 simple or sub-compound spikes; spikes

cylindrical, 1′ long or less, with 50-100 spiklets; spiklets minute, teretish, 1½ lines long, 8 to 10-flowered; glumes closely imbricated, mucronulate, the midvein green; stamens 3, style equaling the glume, with 3 short stigmas, rachis slightly winged. Law.

877. C. inflexus Muhl. Law., Brookville: Popenoe.
878. C. inflexus var. thrice taken. Law.
879. C. acuminatus Torr & Hook, Law.
880. C. filiculmis Vahl. Law.
881. C. compressus L. Law.
882. C. diandrus Torr. Law.: Snow.

Eleocharis, Spiked Rush.

883. E. palustris R. Br. Law.
884. E. intermedia Schultes. Law., Ell.
885. E. tricostata Torr. Law.
886. E. olivacea Torr. Law.
887. E. tenuis Schultes. Law.
888. E. rostellata Torr. Ell.
889. E. compressa Sullivant. Sal.

Scirpus, Club Rush.

890. S. debilis Ph. Law.
891. S. lacustris L. (validus, Vahl). Bulrush. Law.
892. S. Torreyi Olney. Sal.
893. S. fluviatilis Gr. Law., Sal.
894. S. atrovirens Muhl. Law., Ell., Sal.
895. S. polyphyllus Vahl. Law.: Snow.
896. S. divaricatus Ell. Law.
897. S. lineatus Mx. Law.

Hemicarpha.

898. H. subsquarrosa Nees. Law.

Fimbristylis.

899. F. spadicea Vahl. Sal.
900. F. laxa Vahl. Law.

Trichelostylis.

901. T. autumnalis R. & S. Law.
902. T. capillaris Gr. Law.

Carex, Sedge.

903. C. vulpinoidea Mx. Law., Sal.
904. C. stipata Muhl. Leav.: Wherrell.
905. C. setacea Dew. Irv.: Mrs. Jewell.
906. C. cephalophora Willd. Law.
907. C. Muhlenbergii Schk. Law.: Snow.
908. C. sparganioides Muhl. Irv.: Mrs. Jewell.
909. C. rosea Schk. Leav.: Wherrell.
910. C. scoparia Schk. Law.
911. C. cristata Schw. Law.
912. C. trisperma Dew. Law.
913. C. argyrantha Tuckm. Irv.: Mrs. Jewell.
914. C. Liddoni Boott. Top.: Popenoe.
915. C. straminea Schk. Law.
916. C. fœnea Willd. Law.
917. C. tenera Dew. Law.
918. C. festucacea Schk. Law.: Snow.
919. C. adusta Boott. Law.
920. C. stricta Lam. Law.: Snow.
921. C. aperta Boott. Law.
922. C. æstivalis Curtis. Law.
923. C. oxylepis Torr. Irv.: Mrs. Jewell.
924. C. gracilima Schw. Irv.: Mrs. Jewell.
925. C. Davisii Torr. Law.
926. C. præcox Jacq. Law.
927. C. Richardsonii R. Br. Sal.
928. C. vestita Willd. Law.
929. C. Emmonsii Dew. Law.
930. C. Pennsylvanica Lam.: Mrs. Jewell.
931. C. Novæ-Angliæ Schw. Law.
932. C. stenolepis Torr. Law.: Snow.
933. C. laxiflora Lam. Law.: Snow.
934. C. blanda Dew. Irv.: Mrs. Jewell.
935. C. conoidea Schk. Sal.; also Top.: Popenoe.
936. C. grisea Wahl. Sal.
937. C. granularis Muhl. Law.
938. C. panicea L. Law.
940. C. Hitchcockiana Dew. Law.; also Leav.: Wherrell.
941. C. lanuginosa Mx. Law.: Snow. Also Ellis.
942. C. filiformis L. Sal.
943. C. polymorpha Nutt. Law.: Snow.
944. C. lacustris Willd. Sal., Law.: Snow.
945. C. utriculata Boott. Law.
946. C. ampullacea Good. Law.
947. C. Schweinitzii Dew. Irv.: Mrs. Jewell.
948. †C. alveoluteus. Top.: Popenoe.

GRAMINEÆ.

Leersia, Cut-grass, etc.

949. L. oryzoides Swartz, cut-grass. Law., Sal.
950. L. Virginica Willd., white-grass. Law., Osaw.

Zizania, Wild Rice.

951. Z. aquatica L. Osaw., 11 ft high. Osw.

Agrostis, Red-Top, etc.

952. *A. vulgaris With., red-top. Law.
953. A. alba L., Fiorin grass. Law., Sal.
954. A. scabra Willd., rough hair-grass. Law., Sal.
955. A. elata Trin. Law.

Vilfa, Dropseed-grass.

956. †V. depauperata Torr. E. Kan.: Hull.
957. †V. cuspidata Torr. Law., Sal.
958. †V. airoides Nees & Meyer. Cloud Co.: from Mrs. Jewell.

Sporobolus, Dropseed-grass.

959. S. vaginæflorus Torr. Law., Sal.
960. S. heterolepis Gray. Law.
961. S. cryptandrus Gr. Law., Sal.
962. S. asper Kunth. Law.
963. S. longifolius Wood. Law., Sal. The last two are by some reckoned as one.
964. S. Indicus Brown. Law.; one place.

Cinna, Sweet Reed-grass.

965. C. pendula Trin. Osw.
966. C. arundinacea L. Osaw.

Muhlenbergia, Dropseed-grass.

967. M. glomerata Trin. Law., Ell., Sal.
968. M. Mexicana Trin. Law., Ell., Sal.
969. M. sobolifera Tr. Law.
970. M. sylvatica T. & A. Sal.
971. M. Wildenovii Trin. Osw.
972. M. diffusa Schreb. Law.
973. Muhlenbergia innominata. "Slender, glabrous, branching, one foot high; panicle erect, capillary loose, branches in 3s and 5s, whorled. Spikelets scarcely 1″ long, much shorter than their pedicels. Glumes pointed, rough on the keel, the upper one shorter, but longer than the two equal obtuse three-veined pales which have a few short beards at the base. Comes nearest to M. Mexicana, but is decidedly different by the characters italicized." Thus described by Prof. Wood, Osawatomie, 1873.

Calamagrostis.

974. C. Canadensis Beauv., blue-joint. Law. One place.

Alopecurus, Foxtail.

975. A. aristulatus Mx. Sal.: Sent to Prof. Snow.
976. †A. Alpinus Smith. Sal.

Aristida, Beard-grass.

977. A. gracilis Ell. Sal.
978. A. purpurea Nutt. Sal.
979. A. oligantha Nutt. Sal.

Stipa, Feather-grass.

980. S. juncea Ph. (spartea of some.) Law., Sal.

Oryzopsis, Mountain Rice.

981. O. melanocarpa Muhl. Osw.: Dr. Newlon.

Paspalum.

982. P. sotaceum Mx. Law.
983. P. læve Mx. Osw.; also Rooks Co.: Popenoe.
984. P. fluitans Kunth. Osaw.
985. P. sanguinata Lam., crab-grass. Law.

Panicum, Panic-grass.

986. P. capillare L. Law., Osw.
987. P. autumnale Bosc. Sal.
988. P. proliferum Lam. Law.
989. P. anceps Mx. Law.
990. P. amarum Ell. Law.
991. P. virgatum L. Law., Osw. A fine grass.
992. P. dichotomum L. Law., Sal.
993. P. depauperatum Muhl., sp. var. Sal.
994. P. pauciflorum Ell. Law., Sal.
995. P. pubescens Lam. Law.
996. P. viscidum Ell. Law.: Snow.
997. P. clandestinum L. Law., Ell.

Oplismenus, Cockspur-grass.

998. *O. Crus-galli Kunth. Law. Rare.
—— O. Crus-galli var. muticus. Law., common. Ell., Sal.

Setaria, Bristly Foxtail.

999. *S. glauca Beauv., bottle-grass.
1000. *S. viridis Beauv. Law.; rare.

Cenchrus, Bur-grass.

1001. C. tribuloides L. Law.

Phalaris, Canary-grass.

1002. P. arundinacea L. Law., Sal.

Bromus, Brome-grass.

1003. B. seculinus L., chess. Law., Sal.
1004. B. racemosus L. Law.
1005. B. ciliatus L. Law.

Tricuspis, False Redtop.

1006. T. seslerioides Torr. Law., Osw.; tall and handsome.
1007. T. purpurea Nutt (Uralepis). Law.; on river sand.
1008. †T. acuminata Thurb. Dodge: Popenoe.

Dactylis, Orchard-grass.

1009. *D. glomerata L. Law.

Kæleria.

1010. K. cristata Smith. Law., Sal.
—— K. cristata var. nitida Nutt. Law.

Diarrhena.

1011. D. Americana Beauv. Law.*

Festuca, Fescue-grass.

1012. F. tenella, Willd. Law., Ell., Top.: Popenoe.
1013. F. ovina L., sheep's fescue. Law.
1014. F. nutans Willd. Top.: Popenoe.

Eatonia.

1015. E. obtusata Gr. Law., Osw.

Melica.

1016. M. mutica Walt. Law.

Eragrostis.

1017. E. reptans Nees. Law., Osaw.
1018. E. poæoides Beauv. Law., Ell., Osw.; known by its unpleasant odor.
1019. E. pilosa L. Law.
1020. E. hirsuta Wood. Law.
1021. E. capillaris Nees. Law.
1022. E. tenuis Ell. Law.
1023. E. erythrogona Nees (Frankii, Meyer). Law.

Poa, Spear-grass.

1024. P. annua L. Sal., S. W. Kansas: from Prof. Mudge.
1025. P. compressa L. Blue-grass. Law.
1026. P. sylvestris Gr. Law.
1027. P. trivialis L. Leav.: Wherrell.
1028. *P. pratensis L. Kentucky Blue-grass. Law.

Brizopyrum.

1029. B. spicatum Hook. Ell., W. Kas.: Popenoe.

Glyceria, Manna-grass.

1030. G. acutiflora Torr. Law.
1031. G. nervata Torr. Law.

Unicola, Union-grass.

1032. U. latifolia Mx. Law., Osw.

Phragmites, Reed.

1033. P. communis Trin. Law. In wet places. Eleven feet high.

Lepturus.

1034. L. paniculatus Nutt. Law.

Hordeum, Barley.

1035. H. jubatum L. Sal.
1036. H. pusillum Nutt. Law.

Elymus, Wild Rye.

1037. E. Virginicus L. Ell., Sal.
1038. E. Europæus L. Law., Sal., Osw.
1039. E. Canadensis L. Law., Ell., Sal.
1040. E. striatus Willd. Law., Ell., Sal.
1041. E. Hystrix L. Law.
1042. †E. —— form with 5-7 spikelets at each joint. I thought E. condensatus, but Mr. Hall says it is not.

Triticum, Wheat, &c.

1043. T. repens E. Quick-grass. Sal.
1044. T. violaceum Hornem. Law.

Leptochloa.

1045. L. mucronata Kunth. Law., Osaw.
1046. L. fascicularis Gr. Law.

Eleusine, Yard-grass.

1047. E. Indica L. Law.

Spartina, Cord-grass.

1048. S. cynosuroides Willd. Law., Osw.

Buchloe, Buffalo-grass.

1049. †B. dactyloides Eng. Ell.

Bouteloua, Musket-grass.

1050. B. curtipendula Gr. Law., Osw.
1051. B. oligostachya Torr. Law., Ell., Sal.
1052. B. hirsuta Lag. Law., Sal.

Munroa.

1053. M. squarrosa Torr. Ell.

Tripsacum, Sesame-grass.

1054. T. dactyloides L. Law.

Andropogon, Beard-grass.

1055. A. furcatus Muhl., blue-stem. Law., Sal.; six feet high.
1056. A. scoparius Mx., broom-grass. Law.
1057. †A. Torreyanus Stendel. Sal.

Sorghum.

1058. S. nutans L. Law., Sal., Osw.

HYDROPTERIDES.

Marsilia.

1059. M. quadrifolia L. Ell.
1060. M. vestita Hook. and Grev. Ell.

1061. M. uncinata Braun. Ell.

EQUISETACEÆ.

Equisetum, Horse-tail.

1062. E. arvense L. Law.
1063. E. sylvaticum L. Law.
1064. E. pratense Ehr. Law.: Snow.
1065. E. robustum Braun. Law., Sal.
1066. E. hyemale L. Scouring Rush. Law.

FILICES, FERNS.

Botrychium, Grape Fern.

1067. B. lunarioides Swz. Leav.: Mr. Wilson.
1068. B. Virginicum L. Rattlesnake Fern. Leav., Law.

Polyodium, Polypod.

1069. P. incanum Ph. Burl.: Mrs. J. N. Locke.

Notholæna.

1070. †N. dealbata Kunze. Humboldt. Brought to Prof. Knox.

Onoclea, Sensitive Fern.

1071. O. sensibilis L. Leav.
——— O. sensibilis var. obtusilobata Torr. Leav.: Wilson.

Struthiopteris, Ostrich Fern.

1072. S. Germanica Willd. Law.

Pellæa, Rock Brake.

1073. P. atropurpurea Link. (Pteris, L.; A. Nosorus, Gr.) Leav., Humboldt; Prof. Knox.

Adiantum, Maidenhair.

1074. A. pedatum L. Leav., Law.

Asplenium, Spleenwort.

1075. A. angustifolium Mx. Leav.
1076. A. filix-fœmina Bernh., lady fern. Leav.: Wilson.

Camptosorus, Walking Fern.

1077. C. rhizophyllus Link. (Antigramma, Smith.) Leav.

Woodsia, Rock Polypod.

1078. W. obtusa Torr. Leav.

Cystopteris, Bladder Fern.

1079. C. fragilis Bernh. Leav., Law.

Aspidium, Shield Fern.

1080. A. Goldianum Hook. Leav.
1081. A. spinulosum Willd. Law.: Saunders.

HEPATICÆ.

Marchantia.

1082. M. polymorpha L. Law.: Saunders.

Orders, 107; genera, 443; species, 1082. species not native, about 41; species not east of the Mississippi, 150.

METEOROLOGICAL SUMMARY FOR 1876.

Prof. F. H. Snow's Annual Report As Meteorologist To The State Board Of Agriculture.

Station: Lawrence, Kansas. Latitude 38°58′; longitude 95°16′; elevation of barometer and thermometers, 884 feet above the sea level, and 14 feet above the ground; rain gauge on the ground; anemometer, 105 feet above the ground, on the dome of the University building, 1,150 feet above the sea level.

The chief peculiarities of the weather of 1876 were as follows:

1. The high temperatures of the first two months of the year, which were the warmest January and February on our nine year's record. These were followed by the coldest March on our record; colder than either of the three preceding winter months, and bringing with it seventeen inches of snow.

2. The absence of great extremes of either heat or cold.

3. The large and well-distributed rainfall, which resulted in immense crops of wheat and corn in all parts of the State. This result is mentioned as a peculiarity, not as an exception. In only one of the nine' years record has there been a serious shortening of crops on account of a deficiency in the amount or distribution of the annual rainfall.

TEMPERATURE.

Mean temperature of the year 52°.76, which is only 0°.06 below the mean of the eight preceding years. The highest temperature was 98° on the 23d of June; the lowest temperature was 5° below zero, February 1st

and December 30th, giving a yearly range of 103°. Mean temperature at 7 A. M., 47°.44; at 2 P. M., 62°.33; at 9 P. M., 50°.76.

Mean temperature of the winter months 32°.03 (a slight fraction above the freezing point), which is 3°.62 above the average winter temperature; of the spring, 51°.62, 1°.34 below the average; of the summer, 75°.51, 1°.26 below the average; of the autumn, 51°.87, 0°.53 below the average.

The coldest month of the year was December, with mean temperature of 23°.60; the coldest week was December 24th to 30th, with mean temperature 14°.60; the coldest day was February 1st, with mean temperature 1°.60. The mercury fell below zero only four times, once in February and three times in December.

The warmest month of the year was July, with mean temperature 78°.60; the warmest week was July 15th to 21st, with mean temperature 82°.14; the warmest days were June 23d, July 17th and 19th, each with mean temperature 85°.5. The mercury reached or exceeded 90° on thirty-six days, viz.: six in June, twelve in July, fourteen in August and four in September. The mercury did not reach 100° during the year.

The last frost of spring (quite severe) was on April 5th, the first light frost of autumn was on September 29th, giving an interval of 177 days entirely without frost. The first severe frost of autumn was on October 1st, giving a period of 179 days without severe frost. No frost or cold weather during the year caused any damage to fruit or fruit buds.

RAIN.

The entire amount of rain, including melted snow, was 44.18 inches, which is greater by 5.67 inches than any previous annual rainfall upon our record, and is 11.20 inches above the average annual amount for the eight preceding years. Either rain or snow fell on 102 days. The unusual amount of rain was well distributed, there being no damaging excess or deficiency in any month of the growing season. The longest interval without rain from March 1st to October 1st was nine days. The number of thunder showers was twenty-nine.

SNOW.

The entire depth of snow was 24¾ inches, of which one-fourth of an inch fell in February, 17 inches in March, 3½ inches in November, and 4 inches in December. The last snow of spring was on March 28th; the first snow of autumn was on Nov. 13th.

FACE OF THE SKY.

Average cloudiness of the year, 41.27 per cent. of the sky, which is 4.22 per cent less than the average for the eight preceding years. The number of clear days (less than one-third cloudy) was 182; half-clear days (from one-third to two-thirds cloudy), 105; cloudy (more than two-thirds), 79. There were 49 days without a cloud, and 31 without a trace of sky. August was the clearest month, with mean cloudiness 26.66 per cent.; March was the cloudiest month, with mean cloudiness 60.45 per cent. The mean cloudiness at 7 A. M. was 44.31 per cent.; at 2 P. M., 44.12 per cent.; at 9 P. M., 35.39 per cent.

DIRECTION OF THE WIND.

During the year, three observations daily, the wind was from the N. W. 330 times; S. W., 313 times; S. E., 147 times; N. E., 135 times; S., 66 times; E., 43 times; N., 32 times; W., 22 times; calm, 10 times. The south

(including southwest, south and southeast) winds outnumbered the north (including northwest, north and northeast) winds, in the ratio of 526 to 497.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 148,120. This gives a mean daily velocity of 404.70 miles, and a mean hourly velocity of 16.85 miles. The highest hourly velocity was 75 miles, on April 19th; the highest daily velocity was 1,010 miles, on February 1st; the highest monthly velocity was 15,690 miles, in March. The winds of the first half of the year were much stronger than those of the second half. The lightest winds were in July and August.

BAROMETER.

Mean height of the barometer, 29.102 inches—precisely the same as in 1875. Mean at 7 A. M., 29.126 inches; at 2 P. M., 29.079 inches; at 9 P. M., 29.100 inches. Maximum, 29.754 inches, on November 30th; minimum, 28.434 inches, on October 20th; yearly range, 1.320 inches. The highest monthly mean was in December, 29.260 inches; the lowest was in June, 29.010 inches. The barometer observations are corrected for temperature and instrumental error, but not for elevation.

RELATIVE HUMIDITY.

The average humidity of the air for the year was 66.8; at 7 A. M., 77.9; at 2 P. M., 48.08; at 9 P. M., 74.65. The dampest month was July—mean humidity, 78.6; the dryest month was February, with mean humidity 59. There were only four fogs during the year. The minimum humidity at any single observation was only 7.6 per cent., or about one-thirteenth of saturation.

The following tables give the mean temperature, the extremes of temperature, the relative humidity, and the rainfall for each month of the year 1876, and a comparison with preceding years:

Months	Mean Temperature	Maximum Temperature	Minimum Temperature	Relative Humidity	Rainfall in Inches	Excess or Deficiency of Rainfall
January	34 70	65.5	2	68.4	0.57	0.72†
February	37.80	74 5	—5	59.0	0.36	0.58†
March	34.25	66 0	0	69.4	4.51	2.31*
April	55.60	87.5	30	59.6	3.38	0.46*
May	65.00	89.0	39	64.5	6.75	3.09*
June	70.24	98.0	50	68.6	12.11	8.54*
July	78.60	95.0	60	72.7	3.51	1.32†
August	77.70	94.0	63	72.4	4.45	0.23*
September	64.70	92.0	34	68.6	3.58	0.18*
October	53.40	83.5	25	59.8	1.93	0.41†
November	37.50	72.0	9	70.9	2.60	0.88*
December	23.60	66.0	—5	68.9	0.43	1.47†
Year 1876	52.76	98 0	— 5.0	66.8	44.18	11.20*
" 1875	50.60	99.0	—16.5	65.5	28.87	4.11†
" 1874	54 20	108.0	— 3.0	65.5	28.87	4.11†
" 1873	52.71	104 0	—26.0	64.0	32.94	0.04†
" 1872	51.90	97.0	—18.0	64.4	32.63	0.35†
" 1871	54.30	103.0	— 6.0	.....	33.23	0.25*
" 1870	54.50	102.0	—10.0	68.4	31.38	1.60†
" 1869	50.99	96.0	— 5.0	.....	38.51	5.53*
" 1868	53.36	101.0	—16.5	.....	37.42	4.44*

*Excess. † Deficiency.

LOCUST FLIGHTS EAST OF THE MISSISSIPPI.*

By Prof. C. V. Riley, of St. Louis.

To the unscientific mind there are few things more difficult of apprehension than that species, whether of plants or animals, should be limited in geographical range to areas not separated from the rest of the country by any very marked barriers, or by visible demarkations. Yet it is a fact well known to every naturalist, and the geographical distribution of species forms at once one of the most interesting and one of the most important studies in natural history. Some species have a very limited, others a very wide, range; and while in the course of time—in the lapse of centuries or ages—the limits have altered in the past and will alter in the future, they are, for all practical purposes, permanent in present time. These limits may in fact, for the purpose of illustration, be likened to those which separate different nations. Though frequently divided by purely imaginary lines, the nations of Europe, with their peculiar customs and languages, are well defined. Along the borders where the nations join, there is sometimes more or less commingling; at other times the line of demarkation is abrupt —and in no case could emigrants from the one long perpetuate their peculiarities unchanged in the midst of the other. Yet in the battle of nations the lines have changed, and the map of Europe has often been remodeled. So it is with species. On the borders of the areas not abruptly defined, to which species are limited, there is more or less modification from the typical characters and habits; while in the struggle of species for supremacy, the limits may vary in the course of time. The difference is, that the boundaries of nations result from human rather than natural agencies, while those of species result most from the latter, and are therefore more permanent. It is scarcely necessary to add that these remarks apply to species as they are found in nature, and uninfluenced by man. The spread of species by man's direct or indirect influence is equally interesting; but it is not my purpose to consider it in this connection.

I found some difficulty at the late conference of Governors at Omaha to consider the locust problem, in satisfying those present that the Rocky Mountain locust could not permanently thrive south of the 44th parallel or east of the 100th meridian, and that there was no danger of its ever extending so as to do serious damage east of a meridian line drawn a little west of the center of Iowa. They could not see what there was to prevent the pest from overrunning the whole country, and thought that Congress should be appealed to not alone on behalf of the country that had suffered from its ravages, but on behalf of the whole country that is threatened therefrom. In my last two reports I have discussed the native home of the species, and I will here endeavor to present the conditions which prevent its permanent settlement in the country to which it is not native.

Briefly, the species is at home and can come to perfection only in the high and dry regions of the Northwest, where the winters are long and cold and the summers short: and whenever it migrates and oversweeps the country to the south or southeast, in which it is not indigenous, the changed con-

*This article was first prepared for the *Scientific American*, and was read before the Kansas Academy by request.

ditions are such that the first generation hatched out in that (to it) unnatural climate, either forsakes it on the wing, or perishes from debility, disease and general deterioration. On the soundness of this conclusion depends the future welfare of the most of the more fertile States between the Mississippi and the Rocky Mountains; and science, as well as past experience, shows it to be sound. Upon this hypothesis the people of nearly the whole country so scourged during this year, and so threatened next spring, may console themselves that the evil is but temporary; they may have to fight their tiny foe most desperately next spring, but they have also the assurance that even if he proves master of the field, he will vacate in time to allow of good crops of some of the staples, and that he may not return again for years. On the other hypothesis—for which there is no apparent, and no real reason—ruin stares them inevitably in the face.

The causes which limit the eastward flight of the winged swarms that come from the northwest, are, with the majority of the people, still more difficult to appreciate; for most persons can see no reason why a swarm that overruns the western portions of Minnesota, Iowa and Missouri, should not extend to the eastern borders of the same States, or into Illinois. Indiana, Ohio, and eastward. Without discussing some of the more occult climatic influences that bear on the belief that they never will, the principal arguments rest in the facts that—1st, the power of flight of any insect that has a limited winged existence, must somewhere find a limit; 2d, that all past experience has shown that Caloptenus spretus has never extended, in a general way, beyond the limit indicated, and that as long as the present average conditions of wind and climate prevail, it is reasonable to suppose that it never will.

One of the principal difficulties in the way of a proper apprehension of the facts is found in the failure, in the popular mind, to discriminate between species. The ordinary newspaper writer talks of the grasshopper, or the locust, as though all over the country and all over the world there was but one and the same species. One of the governors present at the conference referred to, was at first fully of the belief that our Rocky Mountain pest came all the way from Asia. In the case of this destructive species, even some entomologists have added to the difficulty by erroneously claiming that it is common all over the country to the Atlantic ocean.

The above thoughts are suggested by the following reports, that have just met my eye, in the Cincinnati Gazette of the 24th inst., from Dayton and Hamilton, respectively:

"The advent of Kansas grasshoppers, over Sunday and until Monday evening, in great numbers throughout this city, is a most remarkable incident. They were found early Sunday morning, and left, as suddenly as they came, on Monday evening."

"A shower of mammoth grasshoppers came down upon our town and vicinity on Saturday night. We have never seen such large ones before, and we understand from old citizens that they are entire strangers in this part of the country. We saw a boy have a string tied to two of them, (which were as long as a man's finger,) trying to drive them, and he succeeded pretty well."

"A flock of grasshoppers alighted in Hamilton about 11 o'clock on Saturday night, from the northwest. Those that were not drowned in the river or killed by the heavy rain, were probably gobbled up before Sunday night by the chickens."

Such reports as these very naturally confirm the unscientific in the idea that the locust plague of the West, or so-called "Kansas grasshopper," has

overstepped the limits entomologists ascribe to it, and is upsetting the conclusions of science. The same swarm passed over Oxford, in the same State, in a southwesterly direction, and fortunately that veteran and well-known apiarian, the Rev. L. L. Langstroth, who has not forgotten to be a close observer, had specimens sent to me. They prove to be the American acridium (Acridium Americanum). As stated in my Eighth Report, it is the largest and most elegant locust, the prevailing color being dark brown, with a pale yellowish line along the middle of the back when the wings are closed. The rest of the body is marked with deep brown, verging to black, with pale reddish-brown, and with whitish or greenish-yellow; the front wings being prettily mottled, the hind wings very faintly greenish, with brown veins, and the hind shanks generally coral-red, with black-tipped white spines. The species is quite variable in color, size and marks, and several of the varieties have been described as distinct species—by the species grinders. It has a wide range, hybernates in the winged condition, and differs not only in size and habits from the Rocky Mountain locust, but entomologically is as widely separated from it as a sheep from a cow. It is a species common over the country every year, and during exceptional years becomes excessively numerous and acquires the migratory habit, its wings being long and well adapted to flying. It has been very abundant the present year, and toward the end of July, while in the unfledged condition, did an immense amount of damage to the cotton and other crops of Georgia and South Carolina. The papers were full of graphic accounts of their destruction, and editors not only very generally took it for granted that they had to do with the Western spretus, but Mr. T. P. Janes, Commissioner of Agriculture for Georgia, in his circular No. 27, supposed they were the same. Specimens which he subsequently sent me, however, at once revealed their true character.

In September, 1875, large swarms of locusts passed over Illinois, and those who were bent on the idea that there was no reason why that State should not be overrun with the Rocky Mauntain locust, found the apparent justification for their views in the said swarms. Yet these proved to be composed of three species,* indigenous to Illinois, and every year common there; and after settling they did no harm, and nothing was heard of their progeny the following spring—all of which would have been very different had it been a question of the Western spretus.

The damage done by some of the more common locusts that occur over the country, is sometimes very great, especially during hot, dry years. In some of the New England States their ravages have, in restricted localities, fairly equaled those of the voracious spretus of the West. But while a few of them, under exceptional circumstances, develop the migratory habit, they none of them ever have, and in all probability never will, compare with Caloptenus spretus in the vastness of its migrations and in its immense power for injury over extensive areas.

In economic entomology, discrimination between species is very important, and a lack of it often leads to most erroneous conclusions. Whenever we hear of locust flights east of the Mississippi, we may rest satisfied that they are not of our Rocky Mountain pest, and are comparatively harmless.

Manhattan, Kas., Oct. 28, 1876.

*The Differential locust (Caloptenus differentialis), the Atlantic locust (Caloptenus Atlantis), and the red-legged locust (Caloptenus femur-rubrum).

ADDITIONS TO KANSAS MAMMALIA.

By M. V. B. Knox, of Baldwin City.

2a. Lynx rufus, var. maculatus, Horsfield and Vigors. Texas Wild Cat. Less frequent than L. rufus.

39. ———. Mouse, taken near Baldwin; not yet identified.

62. Sorex ———. Taken at Coal Creek, 1873, by C. K. Jones.

63. Hesperomys Nuttalli, Harlan. Red Mouse. In Col. Goss' museum, Neosho Falls. Taken at Colony, March 7, 1873, by J. J. Fairbanks.

64. Arvicola pinetorum, LeC. Taken near Baldwin City, 1876.

65. Perognathus flavus, Baird. Taken at Nickerson, Reno county, May, 1876.

66. Blarina talpoides, Gapper. Taken at Baldwin City, by Geo. Cheney, April 6, 1877.

THE INFLUENCE OF FOOD-SELECTION UPON THE EVOLUTION OF ANIMAL LIFE.

By Dr. A. H. Thompson, Topeka, Kansas.

The influence that food-selection exercises in directing the course of the development of animal life, is a factor of the principle of evolution that has scarcely received the attention at the hands of naturalists and physiologists that its importance deserves. Its potency is manifested in such a marked manner as to be, under some circumstances, a prime factor in the determination of great changes in the phenomena of animal life, even of catastrophes, and yet it has been relegated by most philosophic biologists, when recognized at all, to a second or third place in the order of forces. Many are the theories that have been woven and elaborated in regard to the origin and evolution of life, in the name of the developmental principle, and many are the factors that go to make up the argument in favor of each one. But in the table of forces acknowledged, direct, indirect and accidental, food-selection rarely finds a place under any name, and is still more rarely reckoned as more than an accidental influence.

By the term food-selection we designate that power which each particular substance used as food exercises in causing certain species of animals to employ it for sustenance; i. e., it directs the choice of animals towards itself for sufficient reasons to induce them to use it for food, such as convenience, adaptability, etc. If a given species in a certain district be surrounded by a constant supply of its proper food, it is drawn towards it, employs it, and lives;—the food-environment favors life. But it may not be thus permanent and favorable to the perpetuation of a certain stage in the life of a species. In fact, it rarely is so, but may be changeful and inconstant. In this case, the food imposes upon the animal organization employing it, the necessity of ever changing in conformity to the new conditions ever being presented. The power of food to induce change in the animal organism, and maintain or alter it at its own caprices, is the selection which dictates change.

The dependence of animals for life upon the food-supply, is the most apparent fact of their existence. Every process of their physiology, the movement of every muscle, the production of every bone or other tissue, the action of every gland or nerve-cell, the wonderful processes or origin, growth and reproduction, depend for their maintenance and success upon the completeness of the nutritial supply. Nutriment for the tissues, the mysterious pabulum that upholds life, is derived from the food eaten, and consequent upon the acquisition of food is the continuance of life with all its phenomena, as well of the species as of the individual. All animal life, throughout all time, has been thus dependent, and the variation of the quantity or quality of food has caused some modification of all the forms that ever lived upon the earth. Its importance as a potent modifying influence can scarcely be over-estimated, and is, perhaps, second only to cosmical influences in the potency of its effects upon animal life. The pursuit and procurement of food is the one occupation of all animals; their one object in life being the obtaining of it, that life may be maintained and transmitted. Much force is expended by animals in the augmentation of the species, and success in this depends altogether upon the completeness of the food-supply, and its proper assimilation. One of the first indications of insufficiency of food among all animals, man included, is decrease of reproduction.

This paramount dependence of the animal organism upon food, necessitates the adaptation of the organs of the economy that procure, reduce and assimilate it for the nutrition of the tissues, to the kind of food employed. Upon this proposition rests the theory of this paper, i. e., that through the necessity of food to animals, modification necessary to adaptation to the food used has taken place, and that through this adaptive modification extensive differentiation of animal structure has obtained, through the multiplicity of food-changes.

Given the presence of food, the first important function, the first action, indeed, performed by the animal in its procurement, is prehension—the seizing and conveying of the food to the organs of mastication and deglutition. The organs exercising this function are of wonderful variety, but in each species are specially adapted to the kind of food employed. In Mammalia, for instance, the organs of prehension are especially the lips of the mouth, but which are further assisted in many species by other organs, as in Bimana, Quadrumana, Rodentia, and Marsupialia, by the fore limbs; in the elephant, by the proboscis; in the tapir, by the snout; in the ant-eater and giraffe, by the tongue, etc.; and are supplemented, usually, by the teeth, for more forcible seizure and retention.

The next function performed, is mastication. This is effected by the teeth, with their supporting environments—the jaws, muscles, etc. This region is, perhaps, the most readily susceptible to food-changes, and the influence of food-selection. It is the gate-way to the economy upon which the entire alimentary system depends for the nutrient substances that maintain life. It is the set of millstones through which all food must pass, and by which all food must be reduced into digestible form. The masticating region is the most variable of the entire organism, and presents more variety, taken throughout the whole animal world, than any other special region of the economy. The cause of this mutability of structure we assume to be due to the influence of food-selection, exercising its power in modifying the parts with which the food comes so forcibly in contact, on entering the animal system. The masticating apparatus must be adapted, preeminently to the food employed, for upon the adjustment to the work of reduc-

ing it, everything depends. Modification and re-modification in conformity to food-changes is a constant law of the being and uselessness of this region; and this has indeed obtained through the long ages, until the contemporary result in our own time is a wonderful variety of forms of masticating apparatus. This is the work of food-selection—a conformity of tools to material, not of food to organs.

In the further observation of the animal organization, we find the same adaption. Throughout the length of the alimentary canal, in the deglutition, digestion, solution and assimilation of food; in all the processes whereby the food used is converted into nutrient pabulum for the support of the life and growth of the tissues, evolution has performed the work of perfect conformation of the organs to the food as employed. As evidence in point, we may note the difference between the stomach of a ruminant and a carnivore, employing highly specialized forms of extensive classes for examples. In the ruminant the many compartments into which the stomach is divided, the lengthy intestine, and the complicated process necessary for the elaborate digestion and solution of vegetable food, is in marked contrast to the simple stomach and alimentary system of the carnivore, whose food (being animal tissue already converted from the vegetable) requires the merest dissolving preparatory to absorption and assimilation. In the ruminant the long intestine presents an extensive absorbing surface to the slowly-dissolving bolus of vegetable tissue; while in the carnivore, the intestine is short, as absorption of its food is chiefly performed in the stomach, and a long intestine is useless. This is in keeping with the fact that animal food is chiefly dissolved and absorbed in the sac of the stomach, and vegetable, starchy foods are acted upon and absorbed in the intestine. In omnivorous animals, as man, for a mixed diet we find a mixed capacity, while in vegetable feeders and carnivora of all grades, these organs are adapted to the food used.

But let us glance at some other forms as peculiarly adapted to their food, as employed, and the apparent causes for modification.

Taking Rodentia, we find the peculiar feature of the order to be the two strong, curved, cutting, continuously-growing incisors, which are undoubtedly so modified for a purpose. The origin of these specialized teeth must have been the accidental preference of nuts and barks of trees, which induced a variation and developed the peculiar organs, with accompanying modification of the remainder of the denture and of the digestive region. Many of the members of this order became climbers, to obtain their food more readily, and some species took up their abode in the trunks of trees, living an arboreal life convenient to their food, and protected by the plants that bore it. Some of them became burrowers, in order to obtain roots and barks in the ground and the small grains of low plants, and their burrowing habits soon developed their chief protection against their enemies, many of them becoming so completely adapted in their limbs to this work as to be almost incapable of progression upon level ground.

In Bradypus, we find a peculiar adjustment of the curious teeth to the mere crushing of the leaves and shoots of trees, and a remarkable conformation of the stomach to this coarse food, it being divided into compartments by transverse ligatures for the longer retention of food for digestion. But a most peculiar feature in these animals is their adaption to an almost complete arboreal life, by the legs being modified for the suspension of the body beneath the limbs of trees, and its living and moving continually in this position. This peculiarity we claim to be one of the indirect results of food-selection.

In the giraffe we observe another leaf-eater, whose limbs are modified for a terrestrial existence, while it is enabled to reach the branches of trees by means of elongated neck and legs, these having been developed by a preference for the shoots and buds of trees.

In the Carnivora we find strong jaws with strong muscles for the exercise of great power in seizing and tearing prey; also a lithe, elastic and powerful systemic framework, for pursuing and overcoming other animals. As their food requires no mastication, there is no lateral movements of the jaws, in the purest forms, but these are merely capable of extensive opening and forcible closure. In the vegetable-feeder, on the contrary, the lateral movement capacity of the jaws is largely developed to allow of trituration, while extensive and forcible vertical movement is suppressed. The claws of Felidæ may also be reckoned as the product of food-selection, being developed and used in the capturing and tearing of prey.

A remarkable instance of evidence in our favor is found in some of the Cetacea. Balænidæ are noted for the absence of teeth, which are superseded by rows of baleen or whalebone, which fringes the opening of the mouth, and by means of which small sea-animals (chiefly Pteropoda), its food, are strained from the water. This adaption to this food is comparatively recent, as numerous rudimentary teeth are found in the jaws in early fœtal life, evidencing a former condition in which teeth were possessed and used upon different food. The usurpation of these organs by a peculiar growth that is better adapted to the food which plentifully surrounds these animals, indicates a rapid and wonderful power of modification by food-selection. The animal also possesses a very small œsophagus, to guard against the entrance of larger food which has not been reduced for want of teeth.

We are reminded here of an opposite example of a disproportionate power of deglutition—that of ophidia. In these reptiles, the food, often disproportionately large, is swallowed by permission of the articulation of the inferior maxillary and its attachments, which part and separate to a remarkable extent to allow the large object to pass. The denture is formed for seizure and gradual creeping up upon the victim.

But we cannot go into further minutiæ. We have thus glanced at some of the more specialized forms which furnish most marked evidence; but the adaption of form to food is just as perfect in all other species.

As has been already stated, other conditions being in harmony, the persistence of the food-supply will induce and determine the permanence of a given species or genus. The preservation of many species through long geological ages must, in many cases, be due to this law; but the opposite condition of the rapid changing of food, fitful and inconstant conditions, the rapid succession of extremes, will necessarily destroy life, and cause the extinction of a species depending upon it. The mean condition of slow, persistent deviation will cause modification and adaptation of structure, and consequent preservation of life. Almost any species can tolerate a very slight alteration of its food with little inconvenience; and a persistence of the change, inducing a tendency in a certain direction, will inevitably bring its appropriate modification of animal structure, through the simple law of adaptation of form to environments. Food being an important environment of every animal, change in its conditions must enforce change upon the animals depending upon it. Food-selection acting as a persistent, moulding force upon a mutable recipient, the animal organism, the result of its influence in every movement must be alteration of the organism towards the direction of least resistance. This direction of

change must be the one of conformation to the new condition, and adaptation to the new characteristics of the food as presented.

Every species must be capable of converting all food into nutriment that lies within a certain range and limit, and the widening of this limit is a comparatively easy operation. Its extension in a certain direction and contraction in another will, by a continual succession of such movements, bring a total and complete change of form. Branching, deviation by a few groups of members of a species in different directions, may give rise to different forms, and in time become established as forever separate species.

The factors that enter the arena as active causes of the phenomena of changes in the all-potent food environment, are numerous and variable. In the vegetable world, upon which all animals depend for their food either directly or indirectly, the causes inducing its variation as a food are legion; and in the present state of our knowledge very few are even partially understood. There are forces and inter-forces, acting variously and erratically, so that in the main we can comprehend but little of their workings.

Cosmical influences have determined the quantity and quality and the main characteristics of the plant world from the beginning, and through it of the animal world. In the earliest history of the earth, when it was just sufficiently cooled from its cosmical fusion to be habitable for the earliest forms, these were such forms and manifestations of life as the conditions induced and permitted. The meager and lowly-organized animal life was moulded to and subsisted upon the vegetable life which was its cotemporary. This plant life existed undoubtedly—indeed, must have existed—in order to make animal life possible, as the latter unquestionably depended from its genesis upon the plant life coexisting, even though they may have been evolved simultaneously from the primary protoplasmic substance which is the mysterious basis and origin of all organic life. Food-selection, at the first, touched the shadowy, unknown beginnings of life; and has, from its very threshold, held all life in its powerful embrace, molding it as the sculptor does his clay!

Whatever the subtle influences may be, so mysterious yet so potent and forceful—be it peculiarities of soil or air, inconstancy of the methods of fertilization, fortune or misfortune in the struggle for existence—whatever the quiet, irresistible force may be that induces a change in the quantity or quality of a plant as a food for a species of animal, when the change comes the animal must change with it or perish. Suppose a peculiar quality is developed in a plant in a particular locality, and the animal there making it its habitual food prefers the change and follows it closely. Preference leads to habit, variation is begun, natural selection seizes the new tendency, and by the power of food-selection modifies the animal economy to the new food. The same species in another locality may have its food suffer from some influence so as to cause deterioration and become unfit for use, and compel it to adopt a nearly allied plant. This plant having previously been but occasionally used for food, its entire adoption would cause some change in the animal organism, and a variation in a certain direction. Again, a class of plants may develop a peculiar flavor, possibly due to the influence of insect fertilization, and a certain animal in a certain locality being compelled to use this plant, or that may prefer the change, may adopt the new form and become conformed to it as it evolves peculiar characteristics. Accidental preference for single parts of the plant, as the leaves, buds or tender shoots, or nuts, fruits, flowers, roots, bark, etc., leads to habitual employment of the parts and consequent modification of structure, both special and general.

It is not possible to name or describe one completely understood process in this intricate system, but these crude suggestions may direct observation of the principles at work. The subject is so massive, yet so new and unworked, that little can be expected of attempt at elaboration for this paper.

But we will close by reference to one animal upon which food-selection has wrought marked effects, and whose development has been largely influenced by it. I refer to Homo sylvaticus (man). With the appearance of the opposable thumb in man, the era of the teeth as prehensile organs began to decline, until today that function in them is entirely aborted. With the beginning of the artificial reduction of his food from its natural condition dates the great catalogue of changes in his organism, one of the most conspicuous and important of which is the reduction of the masticating region. The art of cooking his food came with intellectual evolution. The brain case increased as the face was suppressed, till to-day it greatly predominates in the contour of the head. The artificial reduction of food has induced a tendency toward the suppression of the teeth and their environments, and in the highest races we find a marked atrophy of this region. We claim that this is due to the softening of food, which has caused mastication to fall lergely into disuse, and that the masticating organs not being employed, or being of no further use to the economy, must, according to law, submit to the doom of useless things, and be expelled. We thus contend that the teeth of man are tending toward final abortion on account of their chief function, mastication, rapidly becoming useless. Like all other organs, they require the stimulus of use to endure their perpetuation in the species, and like all organs that have become useless through altered habits of the species, must be suppressed through the law of economy of growth. As evidence that the tendency is in progress, we may cite the atrophy of the masticating region in the highest races, as compared with its size and strength in the savage, i. e., the smaller muscular development, jaw-bones, teeth, etc. Also in the wisdom-tooth we are the contemporary witnesses of an organ in process of suppression—a very remarkable and interesting phenomenon. This tooth in civilized man to-day is rarely perfect in size or structure; it is usually atrophied, often markedly so; is always inferior in structure to the other teeth in the same denture; is often erupted very late in life, and in some persons never appears; or again, only one or two in the set of four may erupt. This tooth, originally, as in most savage tribes to-day, was the peer of the other molars in quality and usefulness, but in civilized man it is frequently worse than useless on account of the disturbance it frequently occasions by mal-eruption.

The food of man is itself undergoing evolution, and the era of its scientific production is fast approaching. This is progressing at such a rate and with such a tendency, that its ultimate result will be the chemical preparation of the proximate elements of the tissues, which will be used as food alone. The resources of nature are beginning to be felt to be inadequate to meet the demands of the increasing millions of the race for food. Science must come to the rescue, and will produce from inorganic as well as organic nature the compact and simple proximate elements of the tissues, upon which in the time to come, the race will doubtless depend for food. In this form food will require little manipulation preparatory to assimilation, and our species will have reached the highest pinnacle of life when possessing the least animality: and this chiefly by the power of food-selection!

EVIDENCE OF ANCIENT FORESTS IN CENTRAL KANSAS.

By H. C. Towner, of Clay Centre.

In the spring of 1874, my attention was called to a specimen of fossil flora, a leaf of Sassafras cretaceum, from the sandstone ridge called the "Black Hills," a few miles west from our place. A fragment of Phillites Vannouæ, and several sprigs of Glyptostrobus gracillimus, were taken from the same stone which held the larger leaf. During the season of 1874, I was with Prof. Mudge, in the upper Cretaceous; but in the spring of 1875, began a series of explorations with a view of developing, so far as possible, the floral resources of this immediate region. This, with the limited time and means at my command, is a slow work, and hardly yet more than begun; yet, to the present time, I have worked with good success, having developed three different deposits of fossil leaves, numbered in the order or their discovery, and all lying in township 9, range 1, east, in Clay county. The three deposits lie within a radius of about a mile, at an elevation more than 1,500 feet above the sea level, and have already yielded the following genera:

Deciduous.—Sassafras, Aralia, Quercus, Menispermites, Platanus, Greviopsis, Magnolia, Salix, Populus, Todea, Alnus, Laurus, Liquidambar.

Evergreens.—Sequoia, Pinus, Glyptostrobus, Inolepis.

Palm Family.—Cycadites.

I have found these leaves in all shapes—some lying singly, flat and smooth upon the stony matrix, almost perfect; others torn and worn to the last degree, and almost illegible; many rolled up in clusters or concretions; one above another for a dozen thicknesses; and all giving evidence of having been deposited at the bottom of comparatively quiet, smooth waters, as it is only rarely that I find a small fragment bearing ripple-marks. As a matter or course, the substance of the leaf is gone, though in a number of instances I found the woody portion of the stem and large vein in good preservation, after its long sleep of over ten millions of years!

I observed one singular fact, which I found confirmed by Dr. Lesquereux, in his supplement to the "Report on the Cretaceous Flora," namely, that while the different varieties of ancient forest trees were more or less intermingled in all the deposits, still, as a general rule, each particular kind of tree had its own chosen locality; where they grew and flourished through long ages of luxuriant greenness, leading a life of untroubled enjoyment, if we can suppose the vegetable family to enjoy life. Following the rule I have mentioned, the three deposits may be designated as follows: No. 1, Quercus; No. 2, Sassafras; No. 3, Aralia. These three forms are not marked as the only, but as the prevailing, types of their respective localities.

The Sassafras appears to be by far the prevailing form. With its kindred type, Araliopsis, it occupies nearly all of the No. 2 deposit, and encroaches largely upon the others.

Associated with the deciduous trees we find the evergreens, the conifers represented mostly by their cones and small branches and twigs. In nearly every case, these remains are found within the enveloping matrix, and in nine cases out of ten, in the hard black stone, some of which is so charged with iron as to be proof against any common hammer. This last remark requires a little explanation. In the deposits that I have thus far examined, I have found beneath the surface layer of hard black stone a

second layer of soft brown stone, all sand, the surface stratum being hardened mud.

The latest, and so far one of the most interesting discoveries, is that of a Cycadites, in reference to which Dr. Lesquereux writes:

"Now, we have as yet not seen any species of this genus in our Cretaceous. Species of Cycas and Zamites are abundant, especially in the Jurassic. They are seen also, less numerous, however, in the lowest Cretaceous, and very rarely in the upper and middle Cretaceous. Heer has described one species only from the upper Cretaceous of Greenland," etc.

This would seem to indicate that Palms may have formed part of the forest landscape of ancient central Kansas.

While these researches were being made in Clay county, Mr. Charles Sternberg, a most indefatigable explorer, has sent scores of fine specimens from Fort Harker. In former years Prof. Mudge has made most interesting discoveries on the Saline; and Dr. Lesquereux, in 1872, explored the Dakota group from southern Nebraska far into Kansas. The result of these explorations, thus far, has been to develop the fact, that far back in the dim ages of the forgotten past, there grew and flourished here in central Kansas vast forests, comprising most of the trees that now exist only in the temperate zones, with many others almost as exclusively tropical or semi-tropical; that these forests grew on long, low lands, in the midst of, or on the borders of, the great Cretaceous sea, which then rolled its heaving billows over all of what is now western Kansas. The presence of so many tropical and sub-tropical remains proves that a mild and equable climate obtained from the Gulf of Mexico to the arctic regions, as the fossil remains from the Cretaceous beds prove the existence of a warm, shallow sea.

In several places over the region I have explored, I have found impressions of wood and bark—hundreds of these casts stamped indelibly upon the now solid rock, the wood itself being very rarely preserved. Very few of these impressions of wood are ever found in the same deposit with the leaves, indicating, perhaps, that these fragments may have drifted to some distance from the spot whereon the trees grew. I have seen, in a few instances, rocks of hardened clay and sand, covered with sun-cracks, showing conditions analogous to those which now obtain along our own shores.

Thus, this long line of hills and bluffs now known as the "Dakota group" indicates an ancient shore-line, covered with heavy forests, enjoying a mild, even climate, animated and irradiated by the same sun, moon and stars that now sheer and enliven our landscapes; and, probably, the haunts of many of the monsters whose bones we find fossilized in the chalk and shale of the Cretaceous beds. We have yet, I think, no traces of feathered inhabitants of these primeval forests. No animals roamed beneath their silent shades. They lived, fulfilled their destiny, and passed away, leaving behind them imperishable records of their life and usefulness—literally, "Footprints on the sands of time."

THE RIVER BLUFFS.

By Prof. John D. Parker, of Kansas City.

Chief among influences moulding a people are those derived from Nature. Like odors distilled from flowers, or odors playing in sunbeams, the subtle powers of Nature elude analysis. But as the crystal lake mirrors

the landscape which environs it, so Nature is reflected in any people. In the mountains of Greece we find the greatest æsthetical development of the Old World. Italy with its sunshine and flowers, its brilliant skies and outdoor life, developed an indolent but happy people. The canton sprang up amidst the eternal mountains and Alpine glaciers of Switzerland. England, with its comparatively immense shore-line, its fogs distilled from the Gulf stream, and its pastoral lands, developed a strong but phlegmatic race. The New England hills naturally moulded a people possessing the highest and best traits in man. Muscular development was required to subdue Nature, intelligence evolved in developing and applying science to industry, culture was inwrought and polished manners ground out by the attrition of society, and art was engendered by the luxuries which Nature offers to those who hang over with delight and feast upon landscapes. During our civil strife, the love of liberty was found strongly intrenched in the mountainous districts of West Virginia, North Carolina and East Tennessee.

It is the purpose of this paper to inquire, What has Nature done for the higher development of the dwellers on the great central plains of the North American continent?

In wealth and variety of soil the great plains are justly celebrated. Nothing can exceed the depth and fertility of the alluvial deposits. The cereals of the temperate zone grow with almost spontaneity. The sacred phrase has its counterpart, a thousand cattle on a hill. With mineral resources Nature has stored her secret chambers. The offerings of grains and fruits and flowers are in profusion. But what keeps a people living amidst such luxuries from indolence and retrogradation?

Among Nature's opposing forces may be placed river bluffs, an American term applied to cliffs or high banks overhanging streams. The river bluffs constitute an important element in the physical features of the West. The Mississippi river and its numerous and powerful affluents nearly always flow between these bluffs, rising in places as massive walls, and sloping back sometimes for miles from the river on either side with decreasing undulations, and melting away at last in the level prairie. Counting both banks, this system of rivers alone would give a single line of elevations meandering through the great plains something like twenty thousand miles in length, and rising at some points to a height above the river of five hundred feet.

The geology of the river bluffs rests on the following dynamic principles. In an open country like the prairies, rivers possess two elements—a channel, and a flood-plain. During the winter season, and some months in summer, the stream is confined within the channel. But during freshets, and particularly the June freshet, which is swollen by mountain snows, the stream rises and spreads over the flood-plain. Now should the interior of the continent be elevated say a hundred feet by internal forces, the coast line remaining the same, the river would have a greater fall, quicker flow, and more eroding power. A new channel and a new flood-plain would be cut, both of less width, leaving the outer margins of the old flood-plain as an elevated terrace. And the walls of the original suture, or outer banks of the stream, would be left by the receding water to be elevated by such successive epochs into river bluffs. And the partings or lips of any suture in the original crust would be slightly turned up by escaping steam or gases, or outward pressure of the yielding mass beneath, leaving the bluff elevated above the surrounding prairie. Four such elevations have taken place since the rivers of the eastern portion of the continent began to flow, and three since the Mississippi began to pursue its course toward the Gulf. As the

geological elevation has been greatest toward the interior and western portions of the continent, the eroding power of rivers has proportionally increased, causing the river bluffs to become more prominent as physical features of the country as we ascend the rivers, just as we shall see where they are needed.

The meteorology of the river bluffs is an important element to those dwelling on the great plains. People always living among hills crowned with forests do not realize the force or constancy of the winds in a level prairie country. At Lawrence, Kansas, for example (a place not exposed as much as many points farther west), the self-registering anemometer on the University building, situated on Mount Oread, furnishes the following record: During the year 1875 the wind traveled 145,316 miles, which gives a mean daily velocity of over 398 miles, and an hourly velocity of over 16 miles. These total winds, flowing uniformly over the whole year, would give the people of Lawrence a constant current of air between a fresh breeze and a strong wind. On January 8, 1875, at the same place, the wind attained a velocity of seventy-five miles an hour, a velocity [illegible] the [illegible] from a hurricane.

The same general belts of wind, running east and west, prevail around the globe. But the forest-covered hills of New England and the Middle States drive these currents up into the upper regions of the atmosphere. Now the river bluffs are the natural wind-breaks of the great central plains, and without them the prairies would be a [illegible] an almost [illegible] [illegible].

[illegible] have observed that [illegible] streams [illegible] [illegible] of the principles [illegible] Streams [illegible] the [illegible] as an [illegible] [illegible] [illegible]

people. In the great plains almost the only elevations are found along the rivers. From these heights the prairies with their green carpets richly ornamented with flowers unfold before us. Nothing compares to a prairie scene except the mighty ocean. The blue vault hangs over us more cerulean than in Eastern climes, the river winds its silver thread between the bluffs until it seems to be broken, and the undulating prairie rolls all around us like the ocean. With such scenes ever before a people can there be decay in poetry, painting or sculpture?

The home life of the river bluffs is an essential element. Nearly all our Western cities and smaller towns, containing quite a proportion of the population, are found along the rivers, nestled in the bluffs. The luxury of hills is thus brought to our very doors. No one is in condition to enjoy this luxury until deprived of it. When hills are piled on hills, as in some of the States, there is too much of a good thing. Desserts of rich food eaten daintily become a luxury. River bluffs are the desserts of our broad prairies, with which Nature has stored her ample board. The prairies satisfy our physical wants; the bluffs feast our souls. The prairies pour in their ample products until all our store-houses are filled beyond measure. The bluffs lift up our homes and spread the board with ambrosial food. Lifted above the earth we live nearer the gods. We drink in the royal landscape around us, of which poets and painters may only dream. The luxury of a prairie home nestled in the bluffs cannot be portrayed.

At the mouth of the Kansas river, Nature evidently planned a city. From this point the railway system naturally radiates. But the frowning bluffs seem to forbid it. Gradually the bluffs melt away to fill the deep ravines. Easily-graded streets leave terraces on either side, to be the sites of comfortable homes, while the crests, with finer views, are crowned with mansions. We love homes lifted a little above the busy street on terraced heights, surrounded with fountains and trees, fruits and flowers. Such homes are being built all along the Father of Waters—rural retreats of luxury, taste and culture.

To the great central plains of North America, the river bluffs are Nature's richest gift. For ages Nature was slowly moulding them, and setting them as watch-towers through all the land. They shield man from the elements which, unobstructed, would desolate his home; they furnish the conditions of a higher rural life; they disclose rich minerals, which Nature has stored in her secret chambers; they reveal the beauties of Nature hidden in landscapes; they furnish sites for homes of comfort and luxury; they tend to lift a people, in a word, out of a dead level, giving the power of elevation from which flows intelligence, culture, and true refinement; they open a fountain of living waters to slake the thirst of coming millions. The gods dwelt in Mount Olympus, we are told, in the olden time; so here diviner forms seem to descend to dispense to men their richest favors. Here are the lines of light that shall grow brighter and broader, we trust, until the whole land shall be enlightened and filled with true knowledge. Here shall the graces descend into human habitations, filled with sunshine and gladness, as long as rivers flow murmuring to the sea.

The dependence of animals for life upon the food-supply, is the most apparent fact of their existence. Every process of their physiology, the movement of every muscle, the production of every bone or other tissue, the action of every gland or nerve-cell, the wonderful processes or origin, growth and reproduction, depend for their maintenance and success upon the completeness of the nutritial supply. Nutriment for the tissues, the mysterious pabulum that upholds life, is derived from the food eaten, and consequent upon the acquisition of food is the continuance of life with all its phenomena, as well of the species as of the individual. All animal life, throughout all time, has been thus dependent, and the variation of the quantity or quality of food has caused some modification of all the forms that ever lived upon the earth. Its importance as a potent modifying influence can scarcely be over-estimated, and is, perhaps, second only to cosmical influences in the potency of its effects upon animal life. The pursuit and procurement of food is the one occupation of all animals; their one object in life being the obtaining of it, that life may be maintained and transmitted. Much force is expended by animals in the augmentation of the species, and success in this depends altogether upon the completeness of the food-supply, and its proper assimilation. One of the first indications of insufficiency of food among all animals, man included, is decrease of reproduction.

This paramount dependence of the animal organism upon food, necessitates the adaptation of the organs of the economy that procure, reduce and assimilate it for the nutrition of the tissues, to the kind of food employed. Upon this proposition rests the theory of this paper, i. e., that through the necessity of food to animals, modification necessary to adaptation to the food used has taken place, and that through this adaptive modification extensive differentiation of animal structure has obtained, through the multiplicity of food-changes.

Given the presence of food, the first important function, the first action, indeed, performed by the animal in its procurement, is prehension—the seizing and conveying of the food to the organs of mastication and deglutition. The organs exercising this function are of wonderful variety, but in each species are specially adapted to the kind of food employed. In Mammalia, for instance, the organs of prehension are especially the lips of the mouth. but which are further assisted in many species by other organs, as in Bimana, Quadrumana, Rodentia, and Marsupialia, by the fore limbs; in the elephant, by the proboscis; in the tapir, by the snout; in the ant-eater and giraffe, by the tongue, etc.; and are supplemented, usually, by the teeth, for more forcible seizure and retention.

The next function performed, is mastication. This is effected by the teeth, with their supporting environments—the jaws, muscles, etc. This region is, perhaps, the most readily susceptible to food-changes, and the influence of food-selection. It is the gate-way to the economy upon which the entire alimentary system depends for the nutrient substances that maintain life. It is the set of millstones through which all food must pass, and by which all food must be reduced into digestible form. The masticating region is the most variable of the entire organism, and presents more variety, taken throughout the whole animal world, than any other special region of the economy. The cause of this mutability of structure we assume to be due to the influence of food-selection, exercising its power in modifying the parts with which the food comes so forcibly in contact, on entering the animal system. The masticating apparatus must be adapted, preeminently, to the food employed, for upon the adjustment to the work of reduc-

ing it, everything depends. Modification and re-modification in conformity to food-changes is a constant law of the being and uselessness of this region; and this has indeed obtained through the long ages, until the contemporary result in our own time is a wonderful variety of forms of masticating apparatus. This is the work of food-selection—a conformity of tools to material, not of food to organs.

In the further observation of the animal organization, we find the same adaption. Throughout the length of the alimentary canal, in the deglutition, digestion, solution and assimilation of food; in all the processes whereby the food used is converted into nutrient pabulum for the support of the life and growth of the tissues, evolution has performed the work of perfect conformation of the organs to the food as employed. As evidence in point, we may note the difference between the stomach of a ruminant and a carnivore, employing highly specialized forms of extensive classes for examples. In the ruminant the many compartments into which the stomach is divided, the lengthy intestine, and the complicated process necessary for the elaborate digestion and solution of vegetable food, is in marked contrast to the simple stomach and alimentary system of the carnivore, whose food (being animal tissue already converted from the vegetable) requires the merest dissolving preparatory to absorption and assimilation. In the ruminant the long intestine presents an extensive absorbing surface to the slowly-dissolving bolus of vegetable tissue; while in the carnivore, the intestine is short, as absorption of its food is chiefly performed in the stomach, and a long intestine is useless. This is in keeping with the fact that animal food is chiefly dissolved and absorbed in the sac of the stomach, and vegetable, starchy foods are acted upon and absorbed in the intestine. In omnivorous animals, as man, for a mixed diet we find a mixed capacity, while in vegetable feeders and carnivora of all grades, these organs are adapted to the food used.

But let us glance at some other forms as peculiarly adapted to their food, as employed, and the apparent causes for modification.

Taking Rodentia, we find the peculiar feature of the order to be the two strong, curved, cutting, continuously-growing incisors, which are undoubtedly so modified for a purpose. The origin of these specialized teeth must have been the accidental preference of nuts and barks of trees, which induced a variation and developed the peculiar organs, with accompanying modification of the remainder of the denture and of the digestive region. Many of the members of this order became climbers, to obtain their food more readily, and some species took up their abode in the trunks of trees, living an arboreal life convenient to their food, and protected by the plants that bore it. Some of them became burrowers, in order to obtain roots and barks in the ground and the small grains of low plants, and their burrowing habits soon developed their chief protection against their enemies, many of them becoming so completely adapted in their limbs to this work as to be almost incapable of progression upon level ground.

In Bradypus, we find a peculiar adjustment of the curious teeth to the mere crushing of the leaves and shoots of trees, and a remarkable conformation of the stomach to this coarse food, it being divided into compartments by transverse ligatures for the longer retention of food for digestion. But a most peculiar feature in these animals is their adaption to an almost complete arboreal life, by the legs being modified for the suspension of the body beneath the limbs of trees, and its living and moving continually in this position. This peculiarity we claim to be one of the indirect results of food-selection.

Aristida, Beard-grass.

977. A. gracilis Ell. Sal.
978. A. purpurea Nutt. Sal.
979. A. oligantha Nutt. Sal.

Stipa, Feather-grass.

980. S. juncea Ph. (spartea of some.) Law., Sal.

Oryzopsis, Mountain Rice.

981. O. melanocarpa Muhl. Osw.: Dr. Newlon.

Paspalum.

982. P. sotaceum Mx. Law.
983. P. læve Mx. Osw.; also Rooks Co.: Popenoe.
984. P. fluitans Kunth. Osaw.
985. P. sanguinata Lam., crab-grass. Law.

Panicum, Panic-grass.

986. P. capillare L. Law., Osw.
987. P. autumnale Bosc. Sal.
988. P. proliferum Lam. Law.
989. P. anceps Mx. Law.
990. P. amarum Ell. Law.
991. P. virgatum L. Law., Osw. A fine grass.
992. P. dichotomum L. Law., Sal.
993. P. depauperatum Muhl., sp. var. Sal.
994. P. paucifiorum Ell. Law., Sal.
995. P. pubescens Lam. Law.
996. P. viscidum Ell. Law.: Snow.
997. P. clandestinum L. Law., Ell.

Oplismenus, Cockspur-grass.

998. *O. Crus-galli Kunth. Law. Rare.
—— O. Crus-galli var. muticus. Law., common. Ell., Sal.

Setaria, Bristly Foxtail.

999. *S. glauca Beauv., bottle-grass.
1000. *S. viridis Beauv. Law.; rare.

Cenchrus, Bur-grass.

1001. C. tribuloides L. Law.

Phalaris, Canary-grass.

1002. P. arundinacea L. Law., Sal.

Bromus, Brome-grass.

1003. B. seculinus L., chess. Law., Sal.
1004. B. racemosus L. Law.
1005. B. ciliatus L. Law.

Tricuspis, False Redtop.

1006. T. seslerioides Torr. Law., Osw.; tall and handsome.
1007. T. purpurea Nutt (Uralepis). Law.; on river sand.
1008. †T. acuminata Thurb. Dodge: Popenoe.

Dactylis, Orchard-grass.

1009. *D. glomerata L. Law.

Kæleria.

1010. K. cristata Smith. Law., Sal.
—— K. cristata var. nitida Nutt. Law.

Diarrhena.

1011. D. Americana Beauv. Law.*

Festuca, Fescue-grass.

1012. F. tenella, Willd. Law., Ell., Top.: Popenoe.
1013. F. ovina L., sheep's fescue. Law.
1014. F. nutans Willd. Top.: Popenoe.

Eatonia.

1015. E. obtusata Gr. Law., Osw.

Melica.

1016. M. mutica Walt. Law.

Eragrostis.

1017. E. reptans Nees. Law., Osaw.
1018. E. poæoides Beauv. Law., Ell., Osw.; known by its unpleasant odor.
1019. E. pilosa L. Law.
1020. E. hirsuta Wood. Law.
1021. E. capillaris Nees. Law.
1022. E. tenuis Ell. Law.
1023. E. erythrogona Nees (Frankii, Meyer). Law.

Poa, Spear-grass.

1024. P. annua L. Sal., S. W. Kansas: from Prof. Mudge.
1025. P. compressa L. Blue-grass. Law.
1026. P. sylvestris Gr. Law.
1027. P. trivialis L. Leav.: Wherrell.
1028. *P. pratensis L. Kentucky Blue-grass. Law.

Brizopyrum.

1029. B. spicatum Hook. Ell., W. Kas.: Popenoe.

Glyceria, Manna-grass.

1030. G. acutiflora Torr. Law.
1031. G. nervata Torr. Law.

Unicola, Union-grass.

1032. U. latifolia Mx. Law., Osw.

Phragmites, Reed.

1033. P. communis Trin. Law. In wet places. Eleven feet high.

Lepturus.

1034. L. paniculatus Nutt. Law.

Hordeum, Barley.

1035. H. jubatum L. Sal.
1036. H. pusillum Nutt. Law.

Elymus, Wild Rye.

1037. E. Virginicus L. Ell., Sal.
1038. E. Europæus L. Law., Sal., Osw.
1039. E. Canadensis L. Law., Ell., Sal.
1040. E. striatus Willd. Law., Ell., Sal.
1041. E. Hystrix L. Law.
1042. †E. —— form with 5-7 spikelets at each joint. I thought E. condensatus, but Mr. Hall says it is not.

Triticum, Wheat, &c.

1043. T. repens E. Quick-grass. Sal.
1044. T. violaceum Hornem. Law.

Leptochloa.

1045. L. mucronata Kunth. Law., Osaw.
1046. L. fascicularis Gr. Law.

Eleusine, Yard-grass.

1047. E. Indica L. Law.

Spartina, Cord-grass.

1048. S. cynosuroides Willd. Law., Osw.

Buchloe, Buffalo-grass.

1049. †B. dactyloides Eng. Ell.

Bouteloua, Musket-grass.

1050. B. curtipendula Gr. Law., Osw.
1051. B. oligostachya Torr. Law., Ell., Sal.
1052. B. hirsuta Lag. Law., Sal.

Munroa.

1053. M. squarrosa Torr. Ell.

Tripsacum, Sesame-grass.

1054. T. dactyloides L. Law.

Andropogon, Beard-grass.

1055. A. furcatus Muhl., blue-stem. Law., Sal.; six feet high.
1056. A. scoparius Mx., broom-grass. Law.
1057. †A. Torreyanus Stendel. Sal.

Sorghum.

1058. S. nutans L. Law., Sal., Osw.

HYDROPTERIDES.

Marsilia.

1059. M. quadrifolia L. Ell.
1060. M. vestita Hook. and Grev. Ell.

1061. M. uncinata Braun. Ell.

EQUISETACEÆ.

Equisetum, Horse-tail.

1062. E. arvense L. Law.
1063. E. sylvaticum L. Law.
1064. E. pratense Ehr. Law.: Snow.
1065. E. robustum Braun. Law., Sal.
1066. E. hyemale L. Scouring Rush. Law.

FILICES, FERNS.

Botrychium, Grape Fern.

1067. B. lunarioides Swz. Leav.: Mr. Wilson.
1068. B. Virginicum L. Rattlesnake Fern. Leav., Law.

Polyodium, Polypod.

1069. P. incanum Ph. Burl.: Mrs. J. N. Locke.

Notholæna.

1070. †N. dealbata Kunze. Humboldt. Brought to Prof. Knox.

Onoclea, Sensitive Fern.

1071. O. sensibilis L. Leav.
—— O. sensibilis var. obtusilobata Torr. Leav.: Wilson.

Struthiopteris, Ostrich Fern.

1072. S. Germanica Willd. Law.

Pellæa, Rock Brake.

1073. P. atropurpurea Link. (Pteris, L.; A. Nosorus, Gr.) Leav., Humboldt; Prof. Knox.

Adiantum, Maidenhair.

1074. A. pedatum L. Leav., Law.

Asplenium, Spleenwort.

1075. A. angustifolium Mx. Leav.
1076. A. filix-fœmina Bernh., lady fern. Leav.: Wilson.

Camptosorus, Walking Fern.

1077. C. rhizophyllus Link. (Antigramma, Smith.) Leav.

Woodsia, Rock Polypod.

1078. W. obtusa Torr. Leav.

Cystopteris, Bladder Fern.

1079. C. fragilis Bernh. Leav., Law.

Aspidium, Shield Fern.

1080. A. Goldionum Hook. Leav.
1081. A. spinulosum Willd. Law.: Saunders.

HEPATICÆ.

Marchantia.

1082. M. polymorpha L. Law.: Saunders.

Orders, 107; genera, 443; species, 1082. species not native, about 41; species not east of the Mississippi, 150.

METEOROLOGICAL SUMMARY FOR 1876.

Prof. F. H. Snow's Annual Report As Meteorologist To The State Board Of Agriculture.

Station: Lawrence, Kansas. Latitude 38°58′; longitude 95°16′; elevation of barometer and thermometers, 884 feet above the sea level, and 14 feet above the ground; rain gauge on the ground; anemometer, 105 feet above the ground, on the dome of the University building, 1,150 feet above the sea level.

The chief peculiarities of the weather of 1876 were as follows:

1. The high temperatures of the first two months of the year, which were the warmest January and February on our nine year's record. These were followed by the coldest March on our record; colder than either of the three preceding winter months, and bringing with it seventeen inches of snow.

2. The absence of great extremes of either heat or cold.

3. The large and well-distributed rainfall, which resulted in immense crops of wheat and corn in all parts of the State. This result is mentioned as a peculiarity, not as an exception. In only one of the nine' years record has there been a serious shortening of crops on account of a deficiency in the amount or distribution of the annual rainfall.

TEMPERATURE.

Mean temperature of the year 52°.76, which is only 0°.06 below the mean of the eight preceding years. The highest temperature was 98° on the 23d of June; the lowest temperature was 5° below zero, February 1st

and December 30th, giving a yearly range of 103°. Mean temperature at 7 A. M., 47°.44; at 2 P. M., 62°.33; at 9 P. M., 50°.76.

Mean temperature of the winter months 32°.03 (a slight fraction above the freezing point), which is 3°.62 above the average winter temperature; of the spring, 51°.62, 1°.34 below the average; of the summer, 75°.51, 1°.26 below the average; of the autumn, 51°.87, 0°.53 below the average.

The coldest month of the year was December, with mean temperature of 23°.60; the coldest week was December 24th to 30th, with mean temperature 14°.60; the coldest day was February 1st, with mean temperature 1°.60. The mercury fell below zero only four times, once in February and three times in December.

The warmest month of the year was July, with mean temperature 78°.60; the warmest week was July 15th to 21st, with mean temperature 82°.14; the warmest days were June 23d, July 17th and 19th, each with mean temperature 85°.5. The mercury reached or exceeded 90° on thirty-six days, viz.: six in June, twelve in July, fourteen in August and four in September. The mercury did not reach 100° during the year.

The last frost of spring (quite severe) was on April 5th, the first light frost of autumn was on September 29th, giving an interval of 177 days entireiy without frost. The first severe frost of autumn was on October 1st, giving a period of 179 days without severe frost. No frost or cold weather during the year caused any damage to fruit or fruit buds.

RAIN.

The entire amount of rain, including melted snow, was 44.18 inches, which is greater by 5.67 inches than any previous annual rainfall upon our record, and is 11.20 inches above the average annual amount for the eight preceding years. Either rain or snow fell on 102 days. The unusual amount of rain was well distributed, there being no damaging excess or deficiency in any month of the growing season. The longest interval without rain from March 1st to October 1st was nine days. The number of thunder showers was twenty-nine.

SNOW.

The entire depth of snow was 24¾ inches, of which one-fourth of an inch fell in February, 17 inches in March, 3½ inches in November, and 4 inches in December. The last snow of spring was on March 28th; the first snow of autumn was on Nov. 13th.

FACE OF THE SKY.

Average cloudiness of the year, 41.27 per cent. of the sky, which is 4.22 per cent less than the average for the eight preceding years. The number of clear days (less than one-third cloudy) was 182; half-clear days (from one-third to two-thirds cloudy), 105; cloudy (more than two-thirds), 79. There were 49 days without a cloud, and 31 without a trace of sky. August was the clearest month, with mean cloudiness 26.66 per cent.; March was the cloudiest month, with mean cloudiness 60.45 per cent. The mean cloudiness at 7 A. M. was 44.31 per cent.; at 2 P. M., 44.12 per cent.; at 9 P. M., 35.39 per cent.

DIRECTION OF THE WIND.

During the year, three observations daily, the wind was from the N. W. 330 times; S. W., 313 times; S. E., 147 times; N. E., 135 times; S., 66 times; E., 43 times; N., 32 times; W., 22 times; calm, 10 times. The south

(including southwest, south and southeast) winds outnumbered the north (including northwest, north and northeast) winds, in the ratio of 526 to 497.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 148,120. This gives a mean daily velocity of 404.70 miles, and a mean hourly velocity of 16.85 miles. The highest hourly velocity was 75 miles, on April 19th; the highest daily velocity was 1,010 miles, on February 1st; the highest monthly velocity was 15,690 miles, in March. The winds of the first half of the year were much stronger than those of the second half. The lightest winds were in July and August.

BAROMETER.

Mean height of the barometer, 29.102 inches—precisely the same as in 1875. Mean at 7 A. M., 29.126 inches; at 2 P. M., 29.079 inches; at 9 P. M., 29.100 inches. Maximum, 29.754 inches, on November 30th; minimum, 28.434 inches, on October 20th; yearly range, 1.320 inches. The highest monthly mean was in December, 29.260 inches; the lowest was in June, 29.010 inches. The barometer observations are corrected for temperature and instrumental error, but not for elevation.

RELATIVE HUMIDITY.

The average humidity of the air for the year was 66.8; at 7 A. M., 77.9; at 2 P. M., 48.08; at 9 P. M., 74.65. The dampest month was July—mean humidity, 78.6; the dryest month was February, with mean humidity 59. There were only four fogs during the year. The minimum humidity at any single observation was only 7.6 per cent., or about one-thirteenth of saturation.

The following tables give the mean temperature, the extremes of temperature, the relative humidity, and the rainfall for each month of the year 1876, and a comparison with preceding years:

Months	Mean Temperature	Maximum Temperature	Minimum Temperature	Relative Humidity	Rainfall in Inches	Excess or Deficiency of Rainfall
January	34 70	65.5	2	68.4	0.57	0.72†
February	37.80	74 5	−5	59.0	0.36	0.58†
March	34.25	66 0	0	69.4	4.51	2.31*
April	55.60	87 5	30	59.6	3.38	0.46*
May	65.00	89.0	39	64.5	6.75	3.09*
June	70.24	98.0	50	68.6	12.11	8.54*
July	78.60	95.0	60	72.7	3.51	1.32†
August	77.70	94.0	63	72.4	4.45	0.23*
September	64.70	92.0	34	68.6	3.58	0.18*
October	53.40	83.5	25	59.8	1.93	0.41†
November	37.50	72.0	9	70.9	2.60	0.88*
December	23.60	66.0	−5	68.9	0.43	1.47†
Year 1876	52.76	98 0	− 5.0	66.8	44.18	11.20*
" 1875	50.60	99.0	−16.5	65.5	28.87	4.11†
" 1874	54 20	108.0	− 3.0	65.5	28.87	4.11†
" 1873	52.71	104 0	−26.0	64.0	32.94	0.04†
" 1872	51.90	97.0	−18.0	64.4	32.63	0.35†
" 1871	54.30	103.0	− 6.0	.....	33.23	0.25*
" 1870	54.50	102.0	−10.0	68.4	31.38	1.60†
" 1869	50.99	96.0	− 5.0	.....	38.51	5.53*
" 1868	53.36	101.0	−16.5	.....	37.42	4.44*

*Excess. † Deficiency.

LOCUST FLIGHTS EAST OF THE MISSISSIPPI.*

By Prof. C. V. Riley, of St. Louis.

To the unscientific mind there are few things more difficult of apprehension than that species, whether of plants or animals, should be limited in geographical range to areas not separated from the rest of the country by any very marked barriers, or by visible demarkations. Yet it is a fact well known to every naturalist, and the geographical distribution of species forms at once one of the most interesting and one of the most important studies in natural history. Some species have a very limited, others a very wide, range; and while in the course of time—in the lapse of centuries or ages—the limits have altered in the past and will alter in the future, they are, for all practical purposes, permanent in present time. These limits may in fact, for the purpose of illustration, be likened to those which separate different nations. Though frequently divided by purely imaginary lines, the nations of Europe, with their peculiar customs and languages, are well defined. Along the borders where the nations join, there is sometimes more or less commingling; at other times the line of demarkation is abrupt —and in no case could emigrants from the one long perpetuate their peculiarities unchanged in the midst of the other. Yet in the battle of nations the lines have changed, and the map of Europe has often been remodeled. So it is with species. On the borders of the areas not abruptly defined, to which species are limited, there is more or less modification from the typical characters and habits; while in the struggle of species for supremacy, the limits may vary in the course of time. The difference is, that the boundaries of nations result from human rather than natural agencies, while those of species result most from the latter, and are therefore more permanent. It is scarcely necessary to add that these remarks apply to species as they are found in nature, and uninfluenced by man. The spread of species by man's direct or indirect influence is equally interesting; but it is not my purpose to consider it in this connection.

I found some difficulty at the late conference of Governors at Omaha to consider the locust problem, in satisfying those present that the Rocky Mountain locust could not permanently thrive south of the 44th parallel or east of the 100th meridian, and that there was no danger of its ever extending so as to do serious damage east of a meridian line drawn a little west of the center of Iowa. They could not see what there was to prevent the pest from overrunning the whole country, and thought that Congress should be appealed to not alone on behalf of the country that had suffered from its ravages, but on behalf of the whole country that is threatened therefrom. In my last two reports I have discussed the native home of the species, and I will here endeavor to present the conditions which prevent its permanent settlement in the country to which it is not native.

Briefly, the species is at home and can come to perfection only in the high and dry regions of the Northwest, where the winters are long and cold and the summers short; and whenever it migrates and oversweeps the country to the south or southeast, in which it is not indigenous, the changed con-

*This article was first prepared for the *Scientific American*, and was read before the Kansas Academy by request.

ditions are such that the first generation hatched out in that (to it) unnatural climate, either forsakes it on the wing, or perishes from debility, disease and general deterioration. On the soundness of this conclusion depends the future welfare of the most of the more fertile States between the Mississippi and the Rocky Mountains; and science, as well as past experience, shows it to be sound. Upon this hypothesis the people of nearly the whole country so scourged during this year, and so threatened next spring, may console themselves that the evil is but temporary; they may have to fight their tiny foe most desperately next spring, but they have also the assurance that even if he proves master of the field, he will vacate in time to allow of good crops of some of the staples, and that he may not return again for years. On the other hypothesis—for which there is no apparent, and no real reason—ruin stares them inevitably in the face.

The causes which limit the eastward flight of the winged swarms that come from the northwest, are, with the majority of the people, still more difficult to appreciate; for most persons can see no reason why a swarm that overruns the western portions of Minnesota, Iowa and Missouri, should not extend to the eastern borders of the same States, or into Illinois. Indiana, Ohio, and eastward. Without discussing some of the more occult climatic influences that bear on the belief that they never will, the principal arguments rest in the facts that—1st, the power of flight of any insect that has a limited winged existence, must somewhere find a limit; 2d, that all past experience has shown that Caloptenus spretus has never extended, in a general way, beyond the limit indicated, and that as long as the present average conditions of wind and climate prevail, it is reasonable to suppose that it never will.

One of the principal difficulties in the way of a proper apprehension of the facts is found in the failure, in the popular mind, to discriminate between species. The ordinary newspaper writer talks of the grasshopper, or the locust, as though all over the country and all over the world there was but one and the same species. One of the governors present at the conference referred to, was at first fully of the belief that our Rocky Mountain pest came all the way from Asia. In the case of this destructive species, even some entomologists have added to the difficulty by erroneously claiming that it is common all over the country to the Atlantic ocean.

The above thoughts are suggested by the following reports, that have just met my eye, in the Cincinnati Gazette of the 24th inst., from Dayton and Hamilton, respectively:

"The advent of Kansas grasshoppers, over Sunday and until Monday evening, in great numbers throughout this city, is a most remarkable incident. They were found early Sunday morning, and left, as suddenly as they came, on Monday evening."

"A shower of mammoth grasshoppers came down upon our town and vicinity on Saturday night. We have never seen such large ones before, and we understand from old citizens that they are entire strangers in this part of the country. We saw a boy have a string tied to two of them, (which were as long as a man's finger,) trying to drive them, and he succeeded pretty well."

"A flock of grasshoppers alighted in Hamilton about 11 o'clock on Saturday night, from the northwest. Those that were not drowned in the river or killed by the heavy rain, were probably gobbled up before Sunday night by the chickens."

Such reports as these very naturally confirm the unscientific in the idea that the locust plague of the West, or so-called "Kansas grasshopper," has

overstepped the limits entomologists ascribe to it, and is upsetting the conclusions of science. The same swarm passed over Oxford, in the same State, in a southwesterly direction, and fortunately that veteran and well-known apiarian, the Rev. L. L. Langstroth, who has not forgotten to be a close observer, had specimens sent to me. They prove to be the American acridium (Acridium Americanum). As stated in my Eighth Report, it is the largest and most elegant locust, the prevailing color being dark brown, with a pale yellowish line along the middle of the back when the wings are closed. The rest of the body is marked with deep brown, verging to black, with pale reddish-brown, and with whitish or greenish-yellow; the front wings being prettily mottled, the hind wings very faintly greenish, with brown veins, and the hind shanks generally coral-red, with black-tipped white spines. The species is quite variable in color, size and marks, and several of the varieties have been described as distinct species—by the species grinders. It has a wide range, hybernates in the winged condition, and differs not only in size and habits from the Rocky Mountain locust, but entomologically is as widely separated from it as a sheep from a cow. It is a species common over the country every year, and during exceptional years becomes excessively numerous and acquires the migratory habit, its wings being long and well adapted to flying. It has been very abundant the present year, and toward the end of July, while in the unfledged condition, did an immense amount of damage to the cotton and other crops of Georgia and South Carolina. The papers were full of graphic accounts of their destruction, and editors not only very generally took it for granted that they had to do with the Western spretus, but Mr. T. P. Janes, Commissioner of Agriculture for Georgia, in his circular No. 27, supposed they were the same. Specimens which he subsequently sent me, however, at once revealed their true character.

In September, 1875, large swarms of locusts passed over Illinois, and those who were bent on the idea that there was no reason why that State should not be overrun with the Rocky Mauntain locust, found the apparent justification for their views in the said swarms. Yet these proved to be composed of three species,* indigenous to Illinois, and every year common there; and after settling they did no harm, and nothing was heard of their progeny the following spring—all of which would have been very different had it been a question of the Western spretus.

The damage done by some of the more common locusts that occur over the country, is sometimes very great, especially during hot, dry years. In some of the New England States their ravages have, in restricted localities, fairly equaled those of the voracious spretus of the West. But while a few of them, under exceptional circumstances, develop the migratory habit, they none of them ever have, and in all probability never will, compare with Caloptenus spretus in the vastness of its migrations and in its immense power for injury over extensive areas.

In economic entomology, discrimination between species is very important, and a lack of it often leads to most erroneous conclusions. Whenever we hear of locust flights east of the Mississippi, we may rest satisfied that they are not of our Rocky Mountain pest, and are comparatively harmless.

Manhattan, Kas., Oct. 28, 1876.

*The Differential locust (Caloptenus differentialis), the Atlantic locust (Caloptenus Atlantis), and the red-legged locust (Caloptenus femur-rubrum).

ADDITIONS TO KANSAS MAMMALIA.

By M. V. B. Knox, of Baldwin City.

2a. Lynx rufus, var. maculatus, Horsfield and Vigors. Texas Wild Cat. Less frequent than L. rufus.

39. ———. Mouse, taken near Baldwin; not yet identified.

62. Sorex ———. Taken at Coal Creek, 1873, by C. K. Jones.

63. Hesperomys Nuttalli, Harlan. Red Mouse. In Col. Goss' museum, Neosho Falls. Taken at Colony, March 7, 1873, by J. J. Fairbanks.

64. Arvicola pinetorum, LeC. Taken near Baldwin City, 1876.

65. Perognathus flavus, Baird. Taken at Nickerson, Reno county, May, 1876.

66. Blarina talpoides, Gapper. Taken at Baldwin City, by Geo. Cheney, April 6, 1877.

THE INFLUENCE OF FOOD-SELECTION UPON THE EVOLUTION OF ANIMAL LIFE.

By Dr. A. H. Thompson, Topeka, Kansas.

The influence that food-selection exercises in directing the course of the development of animal life, is a factor of the principle of evolution that has scarcely received the attention at the hands of naturalists and physiologists that its importance deserves. Its potency is manifested in such a marked manner as to be, under some circumstances, a prime factor in the determination of great changes in the phenomena of animal life, even of catastrophes, and yet it has been relegated by most philosophic biologists, when recognized at all, to a second or third place in the order of forces. Many are the theories that have been woven and elaborated in regard to the origin and evolution of life, in the name of the developmental principle, and many are the factors that go to make up the argument in favor of each one. But in the table of forces acknowledged, direct, indirect and accidental, food-selection rarely finds a place under any name, and is still more rarely reckoned as more than an accidental influence.

By the term food-selection we designate that power which each particular substance used as food exercises in causing certain species of animals to employ it for sustenance; i. e., it directs the choice of animals towards itself for sufficient reasons to induce them to use it for food, such as convenience, adaptability, etc. If a given species in a certain district be surrounded by a constant supply of its proper food, it is drawn towards it, employs it, and lives;—the food-environment favors life. But it may not be thus permanent and favorable to the perpetuation of a certain stage in the life of a species. In fact, it rarely is so, but may be changeful and inconstant. In this case, the food imposes upon the animal organization employing it, the necessity of ever changing in conformity to the new conditions ever being presented. The power of food to induce change in the animal organism, and maintain or alter it at its own caprices, is the selection which dictates change.

The dependence of animals for life upon the food-supply, is the most apparent fact of their existence. Every process of their physiology, the movement of every muscle, the production of every bone or other tissue, the action of every gland or nerve-cell, the wonderful processes or origin, growth and reproduction, depend for their maintenance and success upon the completeness of the nutritial supply. Nutriment for the tissues, the mysterious pabulum that upholds life, is derived from the food eaten, and consequent upon the acquisition of food is the continuance of life with all its phenomena, as well of the species as of the individual. All animal life, throughout all time, has been thus dependent, and the variation of the quantity or quality of food has caused some modification of all the forms that ever lived upon the earth. Its importance as a potent modifying influence can scarcely be over-estimated, and is, perhaps, second only to cosmical influences in the potency of its effects upon animal life. The pursuit and procurement of food is the one occupation of all animals; their one object in life being the obtaining of it, that life may be maintained and transmitted. Much force is expended by animals in the augmentation of the species, and success in this depends altogether upon the completeness of the food-supply, and its proper assimilation. One of the first indications of insufficiency of food among all animals, man included, is decrease of reproduction.

This paramount dependence of the animal organism upon food, necessitates the adaptation of the organs of the economy that procure, reduce and assimilate it for the nutrition of the tissues, to the kind of food employed. Upon this proposition rests the theory of this paper, i. e., that through the necessity of food to animals, modification necessary to adaptation to the food used has taken place, and that through this adaptive modification extensive differentiation of animal structure has obtained, through the multiplicity of food-changes.

Given the presence of food, the first important function, the first action, indeed, performed by the animal in its procurement, is prehension—the seizing and conveying of the food to the organs of mastication and deglutition. The organs exercising this function are of wonderful variety, but in each species are specially adapted to the kind of food employed. In Mammalia, for instance, the organs of prehension are especially the lips of the mouth. but which are further assisted in many species by other organs, as in Bimana, Quadrumana, Rodentia, and Marsupialia, by the fore limbs; in the elephant, by the proboscis; in the tapir, by the snout; in the ant-eater and giraffe, by the tongue, etc.; and are supplemented, usually, by the teeth, for more forcible seizure and retention.

The next function performed, is mastication. This is effected by the teeth, with their supporting environments—the jaws, muscles, etc. This region is, perhaps, the most readily susceptible to food-changes, and the influence of food-selection. It is the gate-way to the economy upon which the entire alimentary system depends for the nutrient substances that maintain life. It is the set of millstones through which all food must pass, and by which all food must be reduced into digestible form. The masticating region is the most variable of the entire organism, and presents more variety, taken throughout the whole animal world, than any other special region of the economy. The cause of this mutability of structure we assume to be due to the influence of food-selection, exercising its power in modifying the parts with which the food comes so forcibly in contact, on entering the animal system. The masticating apparatus must be adapted, preeminently, to the food employed, for upon the adjustment to the work of reduc-

ing it, everything depends. Modification and re-modification in conformity to food-changes is a constant law of the being and uselessness of this region; and this has indeed obtained through the long ages, until the contemporary result in our own time is a wonderful variety of forms of masticating apparatus. This is the work of food-selection—a conformity of tools to material, not of food to organs.

In the further observation of the animal organization, we find the same adaption. Throughout the length of the alimentary canal, in the deglutition, digestion, solution and assimilation of food; in all the processes whereby the food used is converted into nutrient pabulum for the support of the life and growth of the tissues, evolution has performed the work of perfect conformation of the organs to the food as employed. As evidence in point, we may note the difference between the stomach of a ruminant and a carnivore, employing highly specialized forms of extensive classes for examples. In the ruminant the many compartments into which the stomach is divided, the lengthy intestine, and the complicated process necessary for the elaborate digestion and solution of vegetable food, is in marked contrast to the simple stomach and alimentary system of the carnivore, whose food (being animal tissue already converted from the vegetable) requires the merest dissolving preparatory to absorption and assimilation. In the ruminant the long intestine presents an extensive absorbing surface to the slowly-dissolving bolus of vegetable tissue; while in the carnivore, the intestine is short, as absorption of its food is chiefly performed in the stomach, and a long intestine is useless. This is in keeping with the fact that animal food is chiefly dissolved and absorbed in the sac of the stomach, and vegetable, starchy foods are acted upon and absorbed in the intestine. In omnivorous animals, as man, for a mixed diet we find a mixed capacity, while in vegetable feeders and carnivora of all grades, these organs are adapted to the food used.

But let us glance at some other forms as peculiarly adapted to their food, as employed, and the apparent causes for modification.

Taking Rodentia, we find the peculiar feature of the order to be the two strong, curved, cutting, continuously-growing incisors, which are undoubtedly so modified for a purpose. The origin of these specialized teeth must have been the accidental preference of nuts and barks of trees, which induced a variation and developed the peculiar organs, with accompanying modification of the remainder of the denture and of the digestive region. Many of the members of this order became climbers, to obtain their food more readily, and some species took up their abode in the trunks of trees, living an arboreal life convenient to their food, and protected by the plants that bore it. Some of them became burrowers, in order to obtain roots and barks in the ground and the small grains of low plants, and their burrowing habits soon developed their chief protection against their enemies, many of them becoming so completely adapted in their limbs to this work as to be almost incapable of progression upon level ground.

In Bradypus, we find a peculiar adjustment of the curious teeth to the mere crushing of the leaves and shoots of trees, and a remarkable conformation of the stomach to this coarse food, it being divided into compartments by transverse ligatures for the longer retention of food for digestion. But a most peculiar feature in these animals is their adaption to an almost complete arboreal life, by the legs being modified for the suspension of the body beneath the limbs of trees, and its living and moving continually in this position. This peculiarity we claim to be one of the indirect results of food-selection.

In the giraffe we observe another leaf-eater, whose limbs are modified for a terrestrial existence, while it is enabled to reach the branches of trees by means of elongated neck and legs, these having been developed by a preference for the shoots and buds of trees.

In the Carnivora we find strong jaws with strong muscles for the exercise of great power in seizing and tearing prey; also a lithe, elastic and powerful systemic framework, for pursuing and overcoming other animals. As their food requires no mastication, there is no lateral movements of the jaws, in the purest forms, but these are merely capable of extensive opening and forcible closure. In the vegetable-feeder, on the contrary, the lateral movement capacity of the jaws is largely developed to allow of trituration, while extensive and forcible vertical movement is suppressed. The claws of Felidæ may also be reckoned as the product of food-selection, being developed and used in the capturing and tearing of prey.

A remarkable instance of evidence in our favor is found in some of the Cetacea. Balænidæ are noted for the absence of teeth, which are superseded by rows of baleen or whalebone, which fringes the opening of the mouth, and by means of which small sea-animals (chiefly Pteropoda), its food, are strained from the water. This adaption to this food is comparatively recent, as numerous rudimentary teeth are found in the jaws in early fœtal life, evidencing a former condition in which teeth were possessed and used upon different food. The usurpation of these organs by a peculiar growth that is better adapted to the food which plentifully surrounds these animals, indicates a rapid and wonderful power of modification by food-selection. The animal also possesses a very small œsophagus, to guard against the entrance of larger food which has not been reduced for want of teeth.

We are reminded here of an opposite example of a disproportionate power of deglutition—that of ophidia. In these reptiles, the food, often disproportionately large, is swallowed by permission of the articulation of the inferior maxillary and its attachments, which part and separate to a remarkable extent to allow the large object to pass. The denture is formed for seizure and gradual creeping up upon the victim.

But we cannot go into further minutiæ. We have thus glanced at some of the more specialized forms which furnish most marked evidence; but the adaption of form to food is just as perfect in all other species.

As has been already stated, other conditions being in harmony, the persistence of the food-supply will induce and determine the permanence of a given species or genus. The preservation of many species through long geological ages must, in many cases, be due to this law; but the opposite condition of the rapid changing of food, fitful and inconstant conditions, the rapid succession of extremes, will necessarily destroy life, and cause the extinction of a species depending upon it. The mean condition of slow, persistent deviation will cause modification and adaptation of structure, and consequent preservation of life. Almost any species can tolerate a very slight alteration of its food with little inconvenience; and a persistence of the change, inducing a tendency in a certain direction, will inevitably bring its appropriate modification of animal structure, through the simple law of adaptation of form to environments. Food being an important environment of every animal, change in its conditions must enforce change upon the animals depending upon it. Food-selection acting as a persistent, moulding force upon a mutable recipient, the animal organism, the result of its influence in every movement must be alteration of the organism towards the direction of least resistance. This direction of

change must be the one of conformation to the new condition, and adaptation to the new characteristics of the food as presented.

Every species must be capable of converting all food into nutriment that lies within a certain range and limit, and the widening of this limit is a comparatively easy operation. Its extension in a certain direction and contraction in another will, by a continual succession of such movements, bring a total and complete change of form. Branching, deviation by a few groups of members of a species in different directions, may give rise to different forms, and in time become established as forever separate species.

The factors that enter the arena as active causes of the phenomena of changes in the all-potent food environment, are numerous and variable. In the vegetable world, upon which all animals depend for their food either directly or indirectly, the causes inducing its variation as a food are legion; and in the present state of our knowledge very few are even partially understood. There are forces and inter-forces, acting variously and erratically, so that in the main we can comprehend but little of their workings.

Cosmical influences have determined the quantity and quality and the main characteristics of the plant world from the beginning, and through it of the animal world. In the earliest history of the earth, when it was just sufficiently cooled from its cosmical fusion to be habitable for the earliest forms, these were such forms and manifestations of life as the conditions induced and permitted. The meager and lowly-organized animal life was moulded to and subsisted upon the vegetable life which was its cotemporary. This plant life existed undoubtedly—indeed, must have existed—in order to make animal life possible, as the latter unquestionably depended from its genesis upon the plant life coexisting, even though they may have been evolved simultaneously from the primary protoplasmic substance which is the mysterious basis and origin of all organic life. Food-selection, at the first, touched the shadowy, unknown beginnings of life; and has, from its very threshold, held all life in its powerful embrace, molding it as the sculptor does his clay!

Whatever the subtle influences may be, so mysterious yet so potent and forceful—be it peculiarities of soil or air, inconstancy of the methods of fertilization, fortune or misfortune in the struggle for existence—whatever the quiet, irresistible force may be that induces a change in the quantity or quality of a plant as a food for a species of animal, when the change comes the animal must change with it or perish. Suppose a peculiar quality is developed in a plant in a particular locality, and the animal there making it its habitual food prefers the change and follows it closely. Preference leads to habit, variation is begun, natural selection seizes the new tendency, and by the power of food-selection modifies the animal economy to the new food. The same species in another locality may have its food suffer from some influence so as to cause deterioration and become unfit for use, and compel it to adopt a nearly allied plant. This plant having previously been but occasionally used for food, its entire adoption would cause some change in the animal organism, and a variation in a certain direction. Again, a class of plants may develop a peculiar flavor, possibly due to the influence of insect fertilization, and a certain animal in a certain locality being compelled to use this plant, or that may prefer the change, may adopt the new form and become conformed to it as it evolves peculiar characteristics. Accidental preference for single parts of the plant, as the leaves, buds or tender shoots, or nuts, fruits, flowers, roots, bark, etc., leads to habitual employment of the parts and consequent modification of structure, both special and general.

It is not possible to name or describe one completely understood process in this intricate system, but these crude suggestions may direct observation of the principles at work. The subject is so massive, yet so new and unworked, that little can be expected of attempt at elaboration for this paper.

But we will close by reference to one animal upon which food-selection has wrought marked effects, and whose development has been largely influenced by it. I refer to Homo sylvaticus (man). With the appearance of the opposable thumb in man, the era of the teeth as prehensile organs began to decline, until today that function in them is entirely aborted. With the beginning of the artificial reduction of his food from its natural condition dates the great catalogue of changes in his organism, one of the most conspicuous and important of which is the reduction of the masticating region. The art of cooking his food came with intellectual evolution. The brain case increased as the face was suppressed, till to-day it greatly predominates in the contour of the head. The artificial reduction of food has induced a tendency toward the suppression of the teeth and their environments, and in the highest races we find a marked atrophy of this region. We claim that this is due to the softening of food, which has caused mastication to fall lergely into disuse, and that the masticating organs not being employed, or being of no further use to the economy, must, according to law, submit to the doom of useless things, and be expelled. We thus contend that the teeth of man are tending toward final abortion on account of their chief function, mastication, rapidly becoming useless. Like all other organs, they require the stimulus of use to endure their perpetuation in the species, and like all organs that have become useless through altered habits of the species, must be suppressed through the law of economy of growth. As evidence that the tendency is in progress, we may cite the atrophy of the masticating region in the highest races, as compared with its size and strength in the savage, i. e., the smaller muscular development, jaw-bones, teeth, etc. Also in the wisdom-tooth we are the contemporary witnesses of an organ in process of suppression—a very remarkable and interesting phenomenon. This tooth in civilized man to-day is rarely perfect in size or structure; it is usually atrophied, often markedly so; is always inferior in structure to the other teeth in the same denture; is often erupted very late in life. and in some persons never appears; or again, only one or two in the set of four may erupt. This tooth, originally, as in most savage tribes to-day, was the peer of the other molars in quality and usefulness, but in civilized man it is frequently worse than useless on account of the disturbance it frequently occasions by mal-eruption.

The food of man is itself undergoing evolution, and the era of its scientific production is fast approaching. This is progressing at such a rate and with such a tendency, that its ultimate result will be the chemical preparation of the proximate elements of the tissues, which will be used as food alone. The resources of nature are beginning to be felt to be inadequate to meet the demands of the increasing millions of the race for food. Science must come to the rescue, and will produce from inorganic as well as organic nature the compact and simple proximate elements of the tissues, upon which. in the time to come, the race will doubtless depend for food. In this form food will require little manipulation preparatory to assimilation, and our species will have reached the highest pinnacle of life when possessing the least animality; and this chiefly by the power of food-selection!

EVIDENCE OF ANCIENT FORESTS IN CENTRAL KANSAS.

By H. C. Towner, of Clay Centre.

In the spring of 1874, my attention was called to a specimen of fossil flora, a leaf of Sassafras cretaceum, from the sandstone ridge called the "Black Hills," a few miles west from our place. A fragment of Phillites Vannouæ, and several sprigs of Glyptostrobus gracillimus, were taken from the same stone which held the larger leaf. During the season of 1874, I was with Prof. Mudge, in the upper Cretaceous; but in the spring of 1875, began a series of explorations with a view of developing, so far as possible, the floral resources of this immediate region. This, with the limited time and means at my command, is a slow work, and hardly yet more than begun; yet, to the present time, I have worked with good success, having developed three different deposits of fossil leaves, numbered in the order or their discovery, and all lying in township 9, range 1, east, in Clay county. The three deposits lie within a radius of about a mile, at an elevation more than 1,500 feet above the sea level, and have already yielded the following genera:

Deciduous.—Sassafras, Aralia, Quercus, Menispermites, Platanus, Greviopsis, Magnolia, Salix, Populus, Todea, Alnus, Laurus, Liquidambar.

Evergreens.—Sequoia, Pinus, Glyptostrobus, Inolepis.

Palm Family.—Cycadites.

I have found these leaves in all shapes—some lying singly, flat and smooth upon the stony matrix, almost perfect; others torn and worn to the last degree, and almost illegible; many rolled up in clusters or concretions; one above another for a dozen thicknesses; and all giving evidence of having been deposited at the bottom of comparatively quiet, smooth waters, as it is only rarely that I find a small fragment bearing ripple-marks. As a matter or course, the substance of the leaf is gone, though in a number of instances I found the woody portion of the stem and large vein in good preservation, after its long sleep of over ten millions of years!

I observed one singular fact, which I found confirmed by Dr. Lesquereux, in his supplement to the "Report on the Cretaceous Flora," namely, that while the different varieties of ancient forest trees were more or less intermingled in all the deposits, still, as a general rule, each particular kind of tree had its own chosen locality; where they grew and flourished through long ages of luxuriant greenness, leading a life of untroubled enjoyment, if we can suppose the vegetable family to enjoy life. Following the rule I have mentioned, the three deposits may be designated as follows: No. 1, Quercus; No. 2, Sassafras; No. 3, Aralia. These three forms are not marked as the only, but as the prevailing, types of their respective localities.

The Sassafras appears to be by far the prevailing form. With its kindred type, Araliopsis, it occupies nearly all of the No. 2 deposit, and encroaches largely upon the others.

Associated with the deciduous trees we find the evergreens, the conifers represented mostly by their cones and small branches and twigs. In nearly every case, these remains are found within the enveloping matrix, and in nine cases out of ten, in the hard black stone, some of which is so charged with iron as to be proof against any common hammer. This last remark requires a little explanation. In the deposits that I have thus far examined, I have found beneath the surface layer of hard black stone a

second layer of soft brown stone, all sand, the surface stratum being hardened mud.

The latest, and so far one of the most interesting discoveries, is that of a Cycadites, in reference to which Dr. Lesquereux writes:

"Now, we have as yet not seen any species of this genus in our Cretaceous. Species of Cycas and Zamites are abundant, especially in the Jurassic. They are seen also, less numerous, however, in the lowest Cretaceous, and very rarely in the upper and middle Cretaceous. Heer has described one species only from the upper Cretaceous of Greenland," etc.

This would seem to indicate that Palms may have formed part of the forest landscape of ancient central Kansas.

While these researches were being made in Clay county, Mr. Charles Sternberg, a most indefatigable explorer, has sent scores of fine specimens from Fort Harker. In former years Prof. Mudge has made most interesting discoveries on the Saline; and Dr. Lesquereux, in 1872, explored the Dakota group from southern Nebraska far into Kansas. The result of these explorations, thus far, has been to develop the fact, that far back in the dim ages of the forgotten past, there grew and flourished here in central Kansas vast forests, comprising most of the trees that now exist only in the temperate zones, with many others almost as exclusively tropical or semi-tropical; that these forests grew on long, low lands, in the midst of, or on the borders of, the great Cretaceous sea, which then rolled its heaving billows over all of what is now western Kansas. The presence of so many tropical and sub-tropical remains proves that a mild and equable climate obtained from the Gulf of Mexico to the arctic regions, as the fossil remains from the Cretaceous beds prove the existence of a warm, shallow sea.

In several places over the region I have explored, I have found impressions of wood and bark—hundreds of these casts stamped indelibly upon the now solid rock, the wood itself being very rarely preserved. Very few of these impressions of wood are ever found in the same deposit with the leaves, indicating, perhaps, that these fragments may have drifted to some distance from the spot whereon the trees grew. I have seen, in a few instances, rocks of hardened clay and sand, covered with sun-cracks, showing conditions analogous to those which now obtain along our own shores.

Thus, this long line of hills and bluffs now known as the "Dakota group" indicates an ancient shore-line, covered with heavy forests, enjoying a mild, even climate, animated and irradiated by the same sun, moon and stars that now sheer and enliven our landscapes; and, probably, the haunts of many of the monsters whose bones we find fossilized in the chalk and shale of the Cretaceous beds. We have yet, I think, no traces of feathered inhabitants of these primeval forests. No animals roamed beneath their silent shades. They lived, fulfilled their destiny, and passed away, leaving behind them imperishable records of their life and usefulness—literally, "Footprints on the sands of time."

THE RIVER BLUFFS.

By Prof. John D. Parker, of Kansas City.

Chief among influences moulding a people are those derived from Nature. Like odors distilled from flowers, or colors playing in sunbeams, the subtle powers of Nature elude analysis. But as the crystal lake mirrors

the landscape which environs it, so Nature is reflected in any people. In the mountains of Greece we find the greatest æsthetical development of the Old World. Italy with its sunshine and flowers, its brilliant skies and outdoor life, developed an indolent but happy people. The canton sprang up amidst the eternal mountains and Alpine glaciers of Switzerland. England, with its comparatively immense shore-line, its fogs distilled from the Gulf stream, and its pastoral lands, developed a strong but phlegmatic race. The New England hills naturally moulded a people possessing the highest and best traits in man. Muscular development was required to subdue Nature, intelligence evolved in developing and applying science to industry, culture was inwrought and polished manners ground out by the attrition of society, and art was engendered by the luxuries which Nature offers to those who hang over with delight and feast upon landscapes. During our civil strife, the love of liberty was found strongly intrenched in the mountainous districts of West Virginia, North Carolina and East Tennessee.

It is the purpose of this paper to inquire, What has Nature done for the higher development of the dwellers on the great central plains of the North American continent?

In wealth and variety of soil the great plains are justly celebrated. Nothing can exceed the depth and fertility of the alluvial deposits. The cereals of the temperate zone grow with almost spontaneity. The sacred phrase has its counterpart, a thousand cattle on a hill. With mineral resources Nature has stored her secret chambers. The offerings of grains and fruits and flowers are in profusion. But what keeps a people living amidst such luxuries from indolence and retrogradation?

Among Nature's opposing forces may be placed river bluffs, an American term applied to cliffs or high banks overhanging streams. The river bluffs constitute an important element in the physical features of the West. The Mississippi river and its numerous and powerful affluents nearly always flow between these bluffs, rising in places as massive walls, and sloping back sometimes for miles from the river on either side with decreasing undulations, and melting away at last in the level prairie. Counting both banks, this system of rivers alone would give a single line of elevations meandering through the great plains something like twenty thousand miles in length, and rising at some points to a height above the river of five hundred feet.

The geology of the river bluffs rests on the following dynamic principles. In an open country like the prairies, rivers possess two elements—a channel, and a flood-plain. During the winter season, and some months in summer, the stream is confined within the channel. But during freshets, and particularly the June freshet, which is swollen by mountain snows, the stream rises and spreads over the flood-plain. Now should the interior of the continent be elevated say a hundred feet by internal forces, the coast line remaining the same, the river would have a greater fall, quicker flow, and more eroding power. A new channel and a new flood-plain would be cut, both of less width, leaving the outer margins of the old flood-plain as an elevated terrace. And the walls of the original suture, or outer banks of the stream, would be left by the receding water to be elevated by such successive epochs into river bluffs. And the partings or lips of any suture in the original crust would be slightly turned up by escaping steam or gases, or outward pressure of the yielding mass beneath, leaving the bluff elevated above the surrounding prairie. Four such elevations have taken place since the rivers of the eastern portion of the continent began to flow, and three since the Mississippi began to pursue its course toward the Gulf. As the

geological elevation has been greatest toward the interior and western portions of the continent, the eroding power of rivers has proportionally increased, causing the river bluffs to become more prominent as physical features of the country as we ascend the rivers, just as we shall see where they are needed.

The meteorology of the river bluffs is an important element to those dwelling on the great plains. People always living among hills crowned with forests do not realize the force or constancy of the winds in a level prairie country. At Lawrence, Kansas, for example (a place not exposed as much as many points farther west), the self-registering anemometer on the University building, situated on Mount Oread, furnishes the following record: During the year 1875 the wind traveled 145,316 miles, which gives a mean daily velocity of over 398 miles, and an hourly velocity of over 16 miles. These total winds, flowing uniformly over the whole year, would give the people of Lawrence a constant current of air between a fresh breeze and a strong wind. On January 8, 1875, at the same place, the wind attained a velocity of seventy-five miles an hour, a violent gale, only one remove from a hurricane.

The same general belts of wind, running east and west, prevail around the globe. But the forest-crowned hills of New England and the Middle States drive these currents up into the higher regions of the atmosphere. Now the river bluffs are the natural wind-breaks of the great central plains, and without them the prairies would be a bleak, an almost uninhabitable plateau.

Many have observed that rain storms follow streams, without understanding the principles involved. Streams saturate the contiguous air, which again yields its moisture to a condensation, which does not reduce the dryer air lying outside at a distance from the river to the dew-point. In a similar manner, a super-saturated sponge will give forth moisture to a pressure under which a partially saturated sponge would not yield a drop. A cool current of air passing over the country would thus cause the condensation of vapor, or the ever-forming rain cloud, to appear to travel along river courses. And the greater precipitation of moisture along river courses has been one essential element in the growth of forests, frequently covering river bluffs to give them more force as wind-breaks.

The horticulture of the river bluffs is worthy a passing thought. The pursuits of any people determine to some extent their character. Horticulture is a scientific pursuit involving mind, and possessing elevating tendencies. Now the river bluffs are the natural home of the horticulturist. The conditions of soil and climate determine this pursuit almost to the exclusion of cereals. The apple, pear, plum, peach, quince and apricot love the bluffs, and the small fruits flourish. Notably the grape finds its home among the bluffs. We see its rich purple clusters peeping out beneath leafy trellis bars up the sides of almost inaccessible heights. A horticultural people sandwiched in all through the great plains, and mingling freely with neighboring communities while discussing cognate topics, are not devoid of influence which tends to lift a people into higher forms of living. When the year comes to his prime and bears to our homes his rich stores, ripened with dew, sunshine and shower, we dream of Eden, the ideal of human earthly perfection.

The æsthetics of the river bluffs must not be neglected. The absence of this element is dangerous to any people. When painters cease to study Nature's habitudes, and galleries of art are neglected, when poets forget to draw from their inspiration and repeat her voices, decay falls on a

people. In the great plains almost the only elevations are found along the rivers. From these heights the prairies with their green carpets richly ornamented with flowers unfold before us. Nothing compares to a prairie scene except the mighty ocean. The blue vault hangs over us more cerulean than in Eastern climes, the river winds its silver thread between the bluffs until it seems to be broken, and the undulating prairie rolls all around us like the ocean. With such scenes ever before a people can there be decay in poetry, painting or sculpture?

The home life of the river bluffs is an essential element. Nearly all our Western cities and smaller towns, containing quite a proportion of the population, are found along the rivers, nestled in the bluffs. The luxury of hills is thus brought to our very doors. No one is in condition to enjoy this luxury until deprived of it. When hills are piled on hills, as in some of the States, there is too much of a good thing. Desserts of rich food eaten daintily become a luxury. River bluffs are the desserts of our broad prairies, with which Nature has stored her ample board. The prairies satisfy our physical wants; the bluffs feast our souls. The prairies pour in their ample products until all our store-houses are filled beyond measure. The bluffs lift up our homes and spread the board with ambrosial food. Lifted above the earth we live nearer the gods. We drink in the royal landscape around us, of which poets and painters may only dream. The luxury of a prairie home nestled in the bluffs cannot be portrayed.

At the mouth of the Kansas river, Nature evidently planned a city. From this point the railway system naturally radiates. But the frowning bluffs seem to forbid it. Gradually the bluffs melt away to fill the deep ravines. Easily-graded streets leave terraces on either side, to be the sites of comfortable homes, while the crests, with finer views, are crowned with mansions. We love homes lifted a little above the busy street on terraced heights, surrounded with fountains and trees, fruits and flowers. Such homes are being built all along the Father of Waters—rural retreats of luxury, taste and culture.

To the great central plains of North America, the river bluffs are Nature's richest gift. For ages Nature was slowly moulding them, and setting them as watch-towers through all the land. They shield man from the elements which, unobstructed, would desolate his home; they furnish the conditions of a higher rural life; they disclose rich minerals, which Nature has stored in her secret chambers; they reveal the beauties of Nature hidden in landscapes; they furnish sites for homes of comfort and luxury; they tend to lift a people, in a word, out of a dead level, giving the power of elevation from which flows intelligence, culture, and true refinement; they open a fountain of living waters to slake the thirst of coming millions. The gods dwelt in Mount Olympus, we are told, in the olden time; so here diviner forms seem to descend to dispense to men their richest favors. Here are the lines of light that shall grow brighter and broader, we trust, until the whole land shall be enlightened and filled with true knowledge. Here shall the graces descend into human habitations, filled with sunshine and gladness, as long as rivers flow murmuring to the sea.

The dependence of animals for life upon the food-supply, is the most apparent fact of their existence. Every process of their physiology, the movement of every muscle, the production of every bone or other tissue, the action of every gland or nerve-cell, the wonderful processes or origin, growth and reproduction, depend for their maintenance and success upon the completeness of the nutritial supply. Nutriment for the tissues, the mysterious pabulum that upholds life, is derived from the food eaten, and consequent upon the acquisition of food is the continuance of life with all its phenomena, as well of the species as of the individual. All animal life, throughout all time, has been thus dependent, and the variation of the quantity or quality of food has caused some modification of all the forms that ever lived upon the earth. Its importance as a potent modifying influence can scarcely be over-estimated, and is, perhaps, second only to cosmical influences in the potency of its effects upon animal life. The pursuit and procurement of food is the one occupation of all animals; their one object in life being the obtaining of it, that life may be maintained and transmitted. Much force is expended by animals in the augmentation of the species, and success in this depends altogether upon the completeness of the food-supply, and its proper assimilation. One of the first indications of insufficiency of food among all animals, man included, is decrease of reproduction.

This paramount dependence of the animal organism upon food, necessitates the adaptation of the organs of the economy that procure, reduce and assimilate it for the nutrition of the tissues, to the kind of food employed. Upon this proposition rests the theory of this paper, i. e., that through the necessity of food to animals, modification necessary to adaptation to the food used has taken place, and that through this adaptive modification extensive differentiation of animal structure has obtained, through the multiplicity of food-changes.

Given the presence of food, the first important function, the first action, indeed, performed by the animal in its procurement, is prehension—the seizing and conveying of the food to the organs of mastication and deglutition. The organs exercising this function are of wonderful variety, but in each species are specially adapted to the kind of food employed. In Mammalia, for instance, the organs of prehension are especially the lips of the mouth. but which are further assisted in many species by other organs, as in Bimana, Quadrumana, Rodentia, and Marsupialia, by the fore limbs; in the elephant, by the proboscis; in the tapir, by the snout; in the ant-eater and giraffe, by the tongue, etc.; and are supplemented, usually, by the teeth, for more forcible seizure and retention.

The next function performed, is mastication. This is effected by the teeth, with their supporting environments—the jaws, muscles, etc. This region is, perhaps, the most readily susceptible to food-changes, and the influence of food-selection. It is the gate-way to the economy upon which the entire alimentary system depends for the nutrient substances that maintain life. It is the set of millstones through which all food must pass, and by which all food must be reduced into digestible form. The masticating region is the most variable of the entire organism, and presents more variety, taken throughout the whole animal world, than any other special region of the economy. The cause of this mutability of structure we assume to be due to the influence of food-selection, exercising its power in modifying the parts with which the food comes so forcibly in contact, on entering the animal system. The masticating apparatus must be adapted, preeminently, to the food employed, for upon the adjustment to the work of reduc-

ing it, everything depends. Modification and re-modification in conformity to food-changes is a constant law of the being and uselessness of this region; and this has indeed obtained through the long ages, until the contemporary result in our own time is a wonderful variety of forms of masticating apparatus. This is the work of food-selection—a conformity of tools to material, not of food to organs.

In the further observation of the animal organization, we find the same adaption. Throughout the length of the alimentary canal, in the deglutition, digestion, solution and assimilation of food; in all the processes whereby the food used is converted into nutrient pabulum for the support of the life and growth of the tissues, evolution has performed the work of perfect conformation of the organs to the food as employed. As evidence in point, we may note the difference between the stomach of a ruminant and a carnivore, employing highly specialized forms of extensive classes for examples. In the ruminant the many compartments into which the stomach is divided, the lengthy intestine, and the complicated process necessary for the elaborate digestion and solution of vegetable food, is in marked contrast to the simple stomach and alimentary system of the carnivore, whose food (being animal tissue already converted from the vegetable) requires the merest dissolving preparatory to absorption and assimilation. In the ruminant the long intestine presents an extensive absorbing surface to the slowly-dissolving bolus of vegetable tissue; while in the carnivore, the intestine is short, as absorption of its food is chiefly performed in the stomach, and a long intestine is useless. This is in keeping with the fact that animal food is chiefly dissolved and absorbed in the sac of the stomach, and vegetable, starchy foods are acted upon and absorbed in the intestine. In omnivorous animals, as man, for a mixed diet we find a mixed capacity, while in vegetable feeders and carnivora of all grades, these organs are adapted to the food used.

But let us glance at some other forms as peculiarly adapted to their food, as employed, and the apparent causes for modification.

Taking Rodentia, we find the peculiar feature of the order to be the two strong, curved, cutting, continuously-growing incisors, which are undoubtedly so modified for a purpose. The origin of these specialized teeth must have been the accidental preference of nuts and barks of trees, which induced a variation and developed the peculiar organs, with accompanying modification of the remainder of the denture and of the digestive region. Many of the members of this order became climbers, to obtain their food more readily, and some species took up their abode in the trunks of trees, living an arboreal life convenient to their food, and protected by the plants that bore it. Some of them became burrowers, in order to obtain roots and barks in the ground and the small grains of low plants, and their burrowing habits soon developed their chief protection against their enemies, many of them becoming so completely adapted in their limbs to this work as to be almost incapable of progression upon level ground.

In Bradypus, we find a peculiar adjustment of the curious teeth to the mere crushing of the leaves and shoots of trees, and a remarkable conformation of the stomach to this coarse food, it being divided into compartments by transverse ligatures for the longer retention of food for digestion. But a most peculiar feature in these animals is their adaption to an almost complete arboreal life, by the legs being modified for the suspension of the body beneath the limbs of trees, and its living and moving continually in this position. This peculiarity we claim to be one of the indirect results of food-selection.

In the giraffe we observe another leaf-eater, whose limbs are modified for a terrestrial existence, while it is enabled to reach the branches of trees by means of elongated neck and legs, these having been developed by a preference for the shoots and buds of trees.

In the Carnivora we find strong jaws with strong muscles for the exercise of great power in seizing and tearing prey; also a lithe, elastic and powerful systemic framework, for pursuing and overcoming other animals. As their food requires no mastication, there is no lateral movements of the jaws, in the purest forms, but these are merely capable of extensive opening and forcible closure. In the vegetable-feeder, on the contrary, the lateral movement capacity of the jaws is largely developed to allow of trituration, while extensive and forcible vertical movement is suppressed. The claws of Felidæ may also be reckoned as the product of food-selection, being developed and used in the capturing and tearing of prey.

A remarkable instance of evidence in our favor is found in some of the Cetacea. Balænidæ are noted for the absence of teeth, which are superseded by rows of baleen or whalebone, which fringes the opening of the mouth, and by means of which small sea-animals (chiefly Pteropoda), its food, are strained from the water. This adaption to this food is comparatively recent, as numerous rudimentary teeth are found in the jaws in early fœtal life, evidencing a former condition in which teeth were possessed and used upon different food. The usurpation of these organs by a peculiar growth that is better adapted to the food which plentifully surrounds these animals, indicates a rapid and wonderful power of modification by food-selection. The animal also possesses a very small œsophagus, to guard against the entrance of larger food which has not been reduced for want of teeth.

We are reminded here of an opposite example of a disproportionate power of deglutition—that of ophidia. In these reptiles, the food, often disproportionately large, is swallowed by permission of the articulation of the inferior maxillary and its attachments, which part and separate to a remarkable extent to allow the large object to pass. The denture is formed for seizure and gradual creeping up upon the victim.

But we cannot go into further minutiæ. We have thus glanced at some of the more specialized forms which furnish most marked evidence; but the adaption of form to food is just as perfect in all other species.

As has been already stated, other conditions being in harmony, the persistence of the food-supply will induce and determine the permanence of a given species or genus. The preservation of many species through long geological ages must, in many cases, be due to this law; but the opposite condition of the rapid changing of food, fitful and inconstant conditions, the rapid succession of extremes, will necessarily destroy life, and cause the extinction of a species depending upon it. The mean condition of slow, persistent deviation will cause modification and adaptation of structure, and consequent preservation of life. Almost any species can tolerate a very slight alteration of its food with little inconvenience; and a persistence of the change, inducing a tendency in a certain direction, will inevitably bring its appropriate modification of animal structure, through the simple law of adaptation of form to environments. Food being an important environment of every animal, change in its conditions must enforce change upon the animals depending upon it. Food-selection acting as a persistent, moulding force upon a mutable recipient, the animal organism, the result of its influence in every movement must be alteration of the organism towards the direction of least resistance. This direction of

change must be the one of conformation to the new condition, and adaptation to the new characteristics of the food as presented.

Every species must be capable of converting all food into nutriment that lies within a certain range and limit, and the widening of this limit is a comparatively easy operation. Its extension in a certain direction and contraction in another will, by a continual succession of such movements, bring a total and complete change of form. Branching, deviation by a few groups of members of a species in different directions, may give rise to different forms, and in time become established as forever separate species.

The factors that enter the arena as active causes of the phenomena of changes in the all-potent food environment, are numerous and variable. In the vegetable world, upon which all animals depend for their food either directly or indirectly, the causes inducing its variation as a food are legion; and in the present state of our knowledge very few are even partially understood. There are forces and inter-forces, acting variously and erratically, so that in the main we can comprehend but little of their workings.

Cosmical influences have determined the quantity and quality and the main characteristics of the plant world from the beginning, and through it of the animal world. In the earliest history of the earth, when it was just sufficiently cooled from its cosmical fusion to be habitable for the earliest forms, these were such forms and manifestations of life as the conditions induced and permitted. The meager and lowly-organized animal life was moulded to and subsisted upon the vegetable life which was its cotemporary. This plant life existed undoubtedly—indeed, must have existed—in order to make animal life possible, as the latter unquestionably depended from its genesis upon the plant life coexisting, even though they may have been evolved simultaneously from the primary protoplasmic substance which is the mysterious basis and origin of all organic life. Food-selection, at the first, touched the shadowy, unknown beginnings of life; and has, from its very threshold, held all life in its powerful embrace, molding it as the sculptor does his clay!

Whatever the subtle influences may be, so mysterious yet so potent and forceful—be it peculiarities of soil or air, inconstancy of the methods of fertilization, fortune or misfortune in the struggle for existence—whatever the quiet, irresistible force may be that induces a change in the quantity or quality of a plant as a food for a species of animal, when the change comes the animal must change with it or perish. Suppose a peculiar quality is developed in a plant in a particular locality, and the animal there making it its habitual food prefers the change and follows it closely. Preference leads to habit, variation is begun, natural selection seizes the new tendency, and by the power of food-selection modifies the animal economy to the new food. The same species in another locality may have its food suffer from some influence so as to cause deterioration and become unfit for use, and compel it to adopt a nearly allied plant. This plant having previously been but occasionally used for food, its entire adoption would cause some change in the animal organism, and a variation in a certain direction. Again, a class of plants may develop a peculiar flavor, possibly due to the influence of insect fertilization, and a certain animal in a certain locality being compelled to use this plant, or that may prefer the change, may adopt the new form and become conformed to it as it evolves peculiar characteristics. Accidental preference for single parts of the plant, as the leaves, buds or tender shoots, or nuts, fruits, flowers, roots, bark, etc., leads to habitual employment of the parts and consequent modification of structure, both special and general.

It is not possible to name or describe one completely understood process in this intricate system, but these crude suggestions may direct observation of the principles at work. The subject is so massive, yet so new and unworked, that little can be expected of attempt at elaboration for this paper.

But we will close by reference to one animal upon which food-selection has wrought marked effects, and whose development has been largely influenced by it. I refer to Homo sylvaticus (man). With the appearance of the opposable thumb in man, the era of the teeth as prehensile organs began to decline, until today that function in them is entirely aborted. With the beginning of the artificial reduction of his food from its natural condition dates the great catalogue of changes in his organism, one of the most conspicuous and important of which is the reduction of the masticating region. The art of cooking his food came with intellectual evolution. The brain case increased as the face was suppressed, till to-day it greatly predominates in the contour of the head. The artificial reduction of food has induced a tendency toward the suppression of the teeth and their environments, and in the highest races we find a marked atrophy of this region. We claim that this is due to the softening of food, which has caused mastication to fall lergely into disuse, and that the masticating organs not being employed, or being of no further use to the economy, must, according to law, submit to the doom of useless things, and be expelled. We thus contend that the teeth of man are tending toward final abortion on account of their chief function, mastication, rapidly becoming useless. Like all other organs, they require the stimulus of use to endure their perpetuation in the species, and like all organs that have become useless through altered habits of the species, must be suppressed through the law of economy of growth. As evidence that the tendency is in progress, we may cite the atrophy of the masticating region in the highest races, as compared with its size and strength in the savage, i. e., the smaller muscular development, jaw-bones, teeth, etc. Also in the wisdom-tooth we are the contemporary witnesses of an organ in process of suppression—a very remarkable and interesting phenomenon. This tooth in civilized man to-day is rarely perfect in size or structure; it is usually atrophied, often markedly so; is always inferior in structure to the other teeth in the same denture; is often erupted very late in life, and in some persons never appears; or again, only one or two in the set of four may erupt. This tooth, originally, as in most savage tribes to-day, was the peer of the other molars in quality and usefulness, but in civilized man it is frequently worse than useless on account of the disturbance it frequently occasions by mal-eruption.

The food of man is itself undergoing evolution, and the era of its scientific production is fast approaching. This is progressing at such a rate and with such a tendency, that its ultimate result will be the chemical preparation of the proximate elements of the tissues, which will be used as food alone. The resources of nature are beginning to be felt to be inadequate to meet the demands of the increasing millions of the race for food. Science must come to the rescue, and will produce from inorganic as well as organic nature the compact and simple proximate elements of the tissues, upon which, in the time to come, the race will doubtless depend for food. In this form food will require little manipulation preparatory to assimilation, and our species will have reached the highest pinnacle of life when possessing the least animality; and this chiefly by the power of food-selection!

EVIDENCE OF ANCIENT FORESTS IN CENTRAL KANSAS.

By H. C. Towner, of Clay Centre.

In the spring of 1874, my attention was called to a specimen of fossil flora, a leaf of Sassafras cretaceum, from the sandstone ridge called the "Black Hills," a few miles west from our place. A fragment of Phillites Vannouæ, and several sprigs of Glyptostrobus gracillimus, were taken from the same stone which held the larger leaf. During the season of 1874, I was with Prof. Mudge, in the upper Cretaceous; but in the spring of 1875, began a series of explorations with a view of developing, so far as possible, the floral resources of this immediate region. This, with the limited time and means at my command, is a slow work, and hardly yet more than begun; yet, to the present time, I have worked with good success, having developed three different deposits of fossil leaves, numbered in the order or their discovery, and all lying in township 9, range 1, east, in Clay county. The three deposits lie within a radius of about a mile, at an elevation more than 1,500 feet above the sea level, and have already yielded the following genera:

Deciduous.—Sassafras, Aralia, Quercus, Menispermites, Platanus, Greviopsis, Magnolia, Salix, Populus, Todea, Alnus, Laurus, Liquidambar.

Evergreens.—Sequoia, Pinus, Glyptostrobus, Inolepis.

Palm Family.—Cycadites.

I have found these leaves in all shapes—some lying singly, flat and smooth upon the stony matrix, almost perfect; others torn and worn to the last degree, and almost illegible; many rolled up in clusters or concretions; one above another for a dozen thicknesses; and all giving evidence of having been deposited at the bottom of comparatively quiet, smooth waters, as it is only rarely that I find a small fragment bearing ripple-marks. As a matter or course, the substance of the leaf is gone, though in a number of instances I found the woody portion of the stem and large vein in good preservation, after its long sleep of over ten millions of years!

I observed one singular fact, which I found confirmed by Dr. Lesquereux, in his supplement to the "Report on the Cretaceous Flora," namely, that while the different varieties of ancient forest trees were more or less intermingled in all the deposits, still, as a general rule, each particular kind of tree had its own chosen locality; where they grew and flourished through long ages of luxuriant greenness, leading a life of untroubled enjoyment, if we can suppose the vegetable family to enjoy life. Following the rule I have mentioned, the three deposits may be designated as follows: No. 1, Quercus; No. 2, Sassafras; No. 3, Aralia. These three forms are not marked as the only, but as the prevailing, types of their respective localities.

The Sassafras appears to be by far the prevailing form. With its kindred type, Araliopsis, it occupies nearly all of the No. 2 deposit, and encroaches largely upon the others.

Associated with the deciduous trees we find the evergreens, the conifers represented mostly by their cones and small branches and twigs. In nearly every case, these remains are found within the enveloping matrix, and in nine cases out of ten, in the hard black stone, some of which is so charged with iron as to be proof against any common hammer. This last remark requires a little explanation. In the deposits that I have thus far examined, I have found beneath the surface layer of hard black stone a

second layer of soft brown stone, all sand, the surface stratum being hardened mud.

The latest, and so far one of the most interesting discoveries, is that of a Cycadites, in reference to which Dr. Lesquereux writes:

"Now, we have as yet not seen any species of this genus in our Cretaceous. Species of Cycas and Zamites are abundant, especially in the Jurassic. They are seen also, less numerous, however, in the lowest Cretaceous, and very rarely in the upper and middle Cretaceous. Heer has described one species only from the upper Cretaceous of Greenland," etc.

This would seem to indicate that Palms may have formed part of the forest landscape of ancient central Kansas.

While these researches were being made in Clay county, Mr. Charles Sternberg, a most indefatigable explorer, has sent scores of fine specimens from Fort Harker. In former years Prof. Mudge has made most interesting discoveries on the Saline; and Dr. Lesquereux, in 1872, explored the Dakota group from southern Nebraska far into Kansas. The result of these explorations, thus far, has been to develop the fact, that far back in the dim ages of the forgotten past, there grew and flourished here in central Kansas vast forests, comprising most of the trees that now exist only in the temperate zones, with many others almost as exclusively tropical or semi-tropical; that these forests grew on long, low lands, in the midst of, or on the borders of, the great Cretaceous sea, which then rolled its heaving billows over all of what is now western Kansas. The presence of so many tropical and sub-tropical remains proves that a mild and equable climate obtained from the Gulf of Mexico to the arctic regions, as the fossil remains from the Cretaceous beds prove the existence of a warm, shallow sea.

In several places over the region I have explored, I have found impressions of wood and bark—hundreds of these casts stamped indelibly upon the now solid rock, the wood itself being very rarely preserved. Very few of these impressions of wood are ever found in the same deposit with the leaves, indicating, perhaps, that these fragments may have drifted to some distance from the spot whereon the trees grew. I have seen, in a few instances, rocks of hardened clay and sand, covered with sun-cracks, showing conditions analogous to those which now obtain along our own shores.

Thus, this long line of hills and bluffs now known as the "Dakota group" indicates an ancient shore-line, covered with heavy forests, enjoying a mild, even climate, animated and irradiated by the same sun, moon and stars that now sheer and enliven our landscapes; and, probably, the haunts of many of the monsters whose bones we find fossilized in the chalk and shale of the Cretaceous beds. We have yet, I think, no traces of feathered inhabitants of these primeval forests. No animals roamed beneath their silent shades. They lived, fulfilled their destiny, and passed away, leaving behind them imperishable records of their life and usefulness—literally, "Footprints on the sands of time."

THE RIVER BLUFFS.

By Prof. John D. Parker, of Kansas City.

Chief among influences moulding a people are those derived from Nature. Like odors distilled from flowers, or colors playing in sunbeams, the subtle powers of Nature elude analysis. But as the crystal lake mirrors

the landscape which environs it, so Nature is reflected in any people. In the mountains of Greece we find the greatest æsthetical development of the Old World. Italy with its sunshine and flowers, its brilliant skies and outdoor life, developed an indolent but happy people. The canton sprang up amidst the eternal mountains and Alpine glaciers of Switzerland. England, with its comparatively immense shore-line, its fogs distilled from the Gulf stream, and its pastoral lands, developed a strong but phlegmatic race. The New England hills naturally moulded a people possessing the highest and best traits in man. Muscular development was required to subdue Nature, intelligence evolved in developing and applying science to industry, culture was inwrought and polished manners ground out by the attrition of society, and art was engendered by the luxuries which Nature offers to those who hang over with delight and feast upon landscapes. During our civil strife, the love of liberty was found strongly intrenched in the mountainous districts of West Virginia, North Carolina and East Tennessee.

It is the purpose of this paper to inquire, What has Nature done for the higher development of the dwellers on the great central plains of the North American continent?

In wealth and variety of soil the great plains are justly celebrated. Nothing can exceed the depth and fertility of the alluvial deposits. The cereals of the temperate zone grow with almost spontaneity. The sacred phrase has its counterpart, a thousand cattle on a hill. With mineral resources Nature has stored her secret chambers. The offerings of grains and fruits and flowers are in profusion. But what keeps a people living amidst such luxuries from indolence and retrogradation?

Among Nature's opposing forces may be placed river bluffs, an American term applied to cliffs or high banks overhanging streams. The river bluffs constitute an important element in the physical features of the West. The Mississippi river and its numerous and powerful affluents nearly always flow between these bluffs, rising in places as massive walls, and sloping back sometimes for miles from the river on either side with decreasing undulations, and melting away at last in the level prairie. Counting both banks, this system of rivers alone would give a single line of elevations meandering through the great plains something like twenty thousand miles in length, and rising at some points to a height above the river of five hundred feet.

The geology of the river bluffs rests on the following dynamic principles. In an open country like the prairies, rivers possess two elements—a channel, and a flood-plain. During the winter season, and some months in summer, the stream is confined within the channel. But during freshets, and particularly the June freshet, which is swollen by mountain snows, the stream rises and spreads over the flood-plain. Now should the interior of the continent be elevated say a hundred feet by internal forces, the coast line remaining the same, the river would have a greater fall, quicker flow, and more eroding power. A new channel and a new flood-plain would be cut, both of less width, leaving the outer margins of the old flood-plain as an elevated terrace. And the walls of the original suture, or outer banks of the stream, would be left by the receding water to be elevated by such successive epochs into river bluffs. And the partings or lips of any suture in the original crust would be slightly turned up by escaping steam or gases, or outward pressure of the yielding mass beneath, leaving the bluff elevated above the surrounding prairie. Four such elevations have taken place since the rivers of the eastern portion of the continent began to flow, and three since the Mississippi began to pursue its course toward the Gulf. As the

geological elevation has been greatest toward the interior and western portions of the continent, the eroding power of rivers has proportionally increased, causing the river bluffs to become more prominent as physical features of the country as we ascend the rivers, just as we shall see where they are needed.

The meteorology of the river bluffs is an important element to those dwelling on the great plains. People always living among hills crowned with forests do not realize the force or constancy of the winds in a level prairie country. At Lawrence, Kansas, for example (a place not exposed as much as many points farther west), the self-registering anemometer on the University building, situated on Mount Oread, furnishes the following record: During the year 1875 the wind traveled 145,316 miles, which gives a mean daily velocity of over 398 miles, and an hourly velocity of over 16 miles. These total winds, flowing uniformly over the whole year, would give the people of Lawrence a constant current of air between a fresh breeze and a strong wind. On January 8, 1875, at the same place, the wind attained a velocity of seventy-five miles an hour, a violent gale, only one remove from a hurricane.

The same general belts of wind, running east and west, prevail around the globe. But the forest-crowned hills of New England and the Middle States drive these currents up into the higher regions of the atmosphere. Now the river bluffs are the natural wind-breaks of the great central plains, and without them the prairies would be a bleak, an almost uninhabitable plateau.

Many have observed that rain storms follow streams, without understanding the principles involved. Streams saturate the contiguous air, which again yields its moisture to a condensation, which does not reduce the dryer air lying outside at a distance from the river to the dew-point. In a similar manner, a super-saturated sponge will give forth moisture to a pressure under which a partially saturated sponge would not yield a drop. A cool current of air passing over the country would thus cause the condensation of vapor, or the ever-forming rain cloud, to appear to travel along river courses. And the greater precipitation of moisture along river courses has been one essential element in the growth of forests, frequently covering river bluffs to give them more force as wind-breaks.

The horticulture of the river bluffs is worthy a passing thought. The pursuits of any people determine to some extent their character. Horticulture is a scientific pursuit involving mind, and possessing elevating tendencies. Now the river bluffs are the natural home of the horticulturist. The conditions of soil and climate determine this pursuit almost to the exclusion of cereals. The apple, pear, plum, peach, quince and apricot love the bluffs, and the small fruits flourish. Notably the grape finds its home among the bluffs. We see its rich purple clusters peeping out beneath leafy trellis bars up the sides of almost inaccessible heights. A horticultural people sandwiched in all through the great plains, and mingling freely with neighboring communities while discussing cognate topics, are not devoid of influence which tends to lift a people into higher forms of living. When the year comes to his prime and bears to our homes his rich stores, ripened with dew, sunshine and shower, we dream of Eden, the ideal of human earthly perfection.

The æsthetics of the river bluffs must not be neglected. The absence of this element is dangerous to any people. When painters cease to study Nature's habitudes, and galleries of art are neglected, when poets forget to draw from their inspiration and repeat her voices, decay falls on a

people. In the great plains almost the only elevations are found along the rivers. From these heights the prairies with their green carpets richly ornamented with flowers unfold before us. Nothing compares to a prairie scene except the mighty ocean. The blue vault hangs over us more cerulean than in Eastern climes, the river winds its silver thread between the bluffs until it seems to be broken, and the undulating prairie rolls all around us like the ocean. With such scenes ever before a people can there be decay in poetry, painting or sculpture?

The home life of the river bluffs is an essential element. Nearly all our Western cities and smaller towns, containing quite a proportion of the population, are found along the rivers, nestled in the bluffs. The luxury of hills is thus brought to our very doors. No one is in condition to enjoy this luxury until deprived of it. When hills are piled on hills, as in some of the States, there is too much of a good thing. Desserts of rich food eaten daintily become a luxury. River bluffs are the desserts of our broad prairies, with which Nature has stored her ample board. The prairies satisfy our physical wants; the bluffs feast our souls. The prairies pour in their ample products until all our store-houses are filled beyond measure. The bluffs lift up our homes and spread the board with ambrosial food. Lifted above the earth we live nearer the gods. We drink in the royal landscape around us, of which poets and painters may only dream. The luxury of a prairie home nestled in the bluffs cannot be portrayed.

At the mouth of the Kansas river, Nature evidently planned a city. From this point the railway system naturally radiates. But the frowning bluffs seem to forbid it. Gradually the bluffs melt away to fill the deep ravines. Easily-graded streets leave terraces on either side, to be the sites of comfortable homes, while the crests, with finer views, are crowned with mansions. We love homes lifted a little above the busy street on terraced heights, surrounded with fountains and trees, fruits and flowers. Such homes are being built all along the Father of Waters—rural retreats of luxury, taste and culture.

To the great central plains of North America, the river bluffs are Nature's richest gift. For ages Nature was slowly moulding them, and setting them as watch-towers through all the land. They shield man from the elements which, unobstructed, would desolate his home; they furnish the conditions of a higher rural life; they disclose rich minerals, which Nature has stored in her secret chambers; they reveal the beauties of Nature hidden in landscapes; they furnish sites for homes of comfort and luxury; they tend to lift a people, in a word, out of a dead level, giving the power of elevation from which flows intelligence, culture, and true refinement; they open a fountain of living waters to slake the thirst of coming millions. The gods dwelt in Mount Olympus, we are told, in the olden time; so here diviner forms seem to descend to dispense to men their richest favors. Here are the lines of light that shall grow brighter and broader, we trust, until the whole land shall be enlightened and filled with true knowledge. Here shall the graces descend into human habitations, filled with sunshine and gladness, as long as rivers flow murmuring to the sea.

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TRANSACTIONS OF THE

KANSAS ACADEMY OF SCIENCE.

REPORT OF THE SECRETARY.

THE TENTH ANNUAL MEETING.

The tenth annual meeting of the Kansas Academy of Science was held in Topeka, October 11th and 12th, 1877. The exercises included two evening lectures and the reading of the following papers:

1. The Internal Heat of the Globe. Prof. B. F. Mudge.
2. The Boston Natural History Society. Prof. M. V. B. Knox.
3. A New Method of Determining the Velocity of the Wind. John H. Long.
4. Notes on the Birds of Kansas. E. A. Popenoe.
5. Ozone in Kansas Atmosphere, II. Prof. W. K. Kedzie.
6. Amblychila cylindriformis Say. Prof. F. H. Snow.
7. Noxious Insects of Kansas in 1877. Geo. F. Gaumer.
8. River Bluffs. John D. Parker.
9. Birds of Ellis County, Kansas. Louis Watson, M. D.
10. The Iola Mineral Well. Prof. W. K. Kedzie.
11. Additions to the Catalogue of Kansas Birds. Prof. F. H. Snow.
12. Science Among the People. Dr. A. H. Thompson.
13. Illustrations of the Nebular Hypothesis. Prof. F. W. Bardwell.
14. The Occurrence of New and Remarkable Dinosaurs in the Wealden of Colorado. Prof. B. F. Mudge.
15. The "Great Spirit" Spring of Mitchell County, Kansas. Prof. W. K. Kedzie.
16. The Insects of Wallace County, Kansas. Prof. F. H. Snow.
17. Catalogue of Kansas Snakes in the State University Museum. Miss Annie E. Mozley.
18. How to Popularize Practical Science. Judge F. G. Adams.
19. The Rattlesnake. S. W. Williston.
20. Colorado Lepidoptera. Prof. F. H. Snow.

The lecture of the first evening was given by Prof. B. F. Mudge, on "The Value of Science," and that of the second evening by Prof. Geo. E. Patrick, on "The Chemistry of the Sun."

The officers elected for the following term of one year were:

F. H. Snow, President.
B. F. Mudge and J. H. Carruth, Vice Presidents.
E. A. Popenoe, Secretary.
R. J. Brown, Treasurer.
F. H. Snow, W. K. Kedzie, and E. A. Popenoe, Curators.

THE SECOND SEMI-ANNUAL MEETING.

The second semi-annual meeting of the Academy was held in Kansas City, June 6th and 7th, 1878, in response to the invitation of the Kansas City Academy of Science.

A lecture upon "Rocky Mountain Geology," by Prof. B. F. Mudge,

and one upon "Steam Navigation," by Prof. F. W. Bardwell, were delivered at the evening sessions, and the day was occupied in an examination of certain mounds in Platte county, Missouri, supposed to be of prehistoric origin. In the mounds were found remains of about twelve skeletons, and several of the skulls and some of the other portions were secured in a fair state of preservation, but the most of the bones found were so extremely fragile that they could not be preserved. The skeletons had been placed in vaults walled with stone, with an entrance toward the south. The walls gave evidence of some care in their construction, being laid very smoothly on the inside. The bones secured were placed in the cabinet of the Kansas Academy of Science.

THE ELEVENTH ANNUAL MEETING.

The eleventh annual meeting of the Academy was held in Topeka, October 8th and 9th, 1878. The first evening's lecture was given by Prof. B. F. Mudge, upon "The Rocky Mountains and their Fossils," and that of the second evening by Prof. D. H. Robinson upon "The Historical Value of Linguistic Study."

The day's session on the 9th was occupied by the reading of the following papers:

1. Connection of the Fossil Forests of the Dakota Group in Kansas with the Fossil Forests of Greenland. Prof. B. F. Mudge.
2. On a New Form of Rain Gauge. Prof. J. T. Lovewell.
3. On some Kansas Minerals. Prof. Geo. E. Patrick.
4. On Recent Additions to the List of Kansas Coleoptera. E. A. Popenoe.
5. On Recent Additions to the List of Kansas Plants. Prof. J. H. Carruth.
6. On the Dermal Covering of a Mosasauroid Reptile of the Cretaceous Formation in Western Kansas. Prof. F. H. Snow.
7. On the Bite of the Rattlesnake. Joseph Savage.
8. On the Habits of Richardson's Sphermophile. S. W. Williston, New Haven, Conn.
9. On the so-called "Alkali" of Western Kansas. Prof. Geo. E. Patrick.
10. On Additions to the Catalogue of Kansas Birds. Prof. F. H. Snow.
11. Notes on the Antiquity of Man. Dr. A. H. Thompson.
12. On Dinosauria. S. W. Williston.
13. On the Gas Wells of Kansas. Prof. B. F. Mudge.
14. On the Remains of the Mastodon in Douglas County. Joseph Savage.
15. On Science Popularized. Marcus Sayler.
16. On the Fishes of the Marais des Cygnes. Wm. Wheeler.
17. Geological Explorations for the year 1878. Prof. B. F. Mudge.
18. Botanical Notes. E. A. Popenoe.
19. On the Giant's Causeway and Fingal's Cave. Prof. C. D. Merrill.
20. On Sound Transmission by Electricity. Prof. J. T. Lovewell.
21. On the Recent Discovery of Mounds in Leavenworth County. Hon. F. G. Adams.
22. On the Discovery of a Fine Specimen of Saurian in Colorado. H. C. Towner.
23. On the Adult Male Plumage of Wilson's Phalarope. S. W. Williston.
24. On the Habits of some Rarer Cicindelæ. S. W. Williston.

25. On the Tusk of a Mastodon found at Ottawa. Wm. Wheeler.

A committee of three, appointed to prepare resolutions of respect to the memory of Gen. John Fraser, and Prof. F. W. Bardwell, members of the Academy, deceased since the last meeting, reported the following:

Resolved, That in the deaths of Gen. John Fraser, one of our former Presidents, and Prof. F. W. Bardwell, both active members, the Academy has lost two ardent supporters, and the country, two men of talent, culture and scientific reputation.

Resolved, That we tender to the families of the departed brothers our warmest sympathies, in their great bereavement.

B. F. Mudge, Chairman.
Jos. Savage.
E. A. Popenoe.

The officers for the ensuing term of one year were chosen as follows:
B. F. Mudge, President.
J. H. Carruth, and Joseph Savage, Vice Presidents.
E. A. Popenoe, Secretary.
R. J. Brown, Treasurer.
F. H. Snow, B. F. Mudge, and E. A. Popenoe, Curators.
The following Commissioners were also appointed:
Geology.—B. F. Mudge, M. V. B. Knox.
Chemistry and Mineralogy.—W. K. Kedzie, G. E. Patrick, R. J. Brown.
Physics.—J. T. Lovewell, L. A. Thomas.
Zoology.—F. H. Snow, M. V. B. Knox, Annie E. Mozley.
Entomology.—F. H. Snow, E. A. Popenoe, William Osburn, Geo. F. Gaumer, T. B. Ashton.
Botany.—J. H. Carruth, E. A. Popenoe.
Anthropology.—A. H. Thompson, J. D. Parker, F. G. Adams.
Philology.—D. H. Robinson, Geo. M. Stearns.
Meteorology.—J. D. Parker, J. T. Lovewell.
Engineering.—Wm. Tweeddale.
Publication Committee.—B. F. Mudge, Alfred Gray, F. H. Snow.
Local Arrangement Committee.—F. G. Adams, A. H. Thompson, Mrs. N. C. McFarland, E. A. Popenoe.

THE LIBRARY AND MUSEUM.

Some small effort has been made, during the past summer, to form the nucleus of a library by exchanging the Transactions of our society for the publications of others. Although the efforts have not been extended as far as they may yet be, the publications received are of considerable value, and it is hoped that all those societies who have so far kindly exchanged will continue to do so, and that others may from time to time be added to the exchange list.

The following is a general list of the publications received:

Bulletin of the Essex Institute, Salem, Mass. Nine octavo volumes.

Transactions of the Davenport Academy of Science. Vol 1, and Part 1, vol. 2. Octavo.

Bulletin of the Torrey Botanical Club, New York. Four octavo volumes.

Proceedings Boston Society Natural History. Vol. 19, parts 1, 2 and 3. Octavo.

Transactions of the Wisconsin Academy of Science, Art and Belles-lettres, Madison. Vol. 3.

Proceedings of the Poughkeepsie Society of Natural Science. Vol. 1, part 1.

Archives of Science and Transactions of the Orleans Co. (Vt.) Society Natural History. Vol. 1.

Bremen Natural Science Society. Vol. 3, part 4; vol. 4, parts 2 and 3, and three quarto pamphlets on Meteorological subjects.

Royal University of Norway. Fourteen pamphlets, 1,000 octavo pages, with many plates.

Topographical Survey of the Adirondacks. One volume, octavo. From Hon. Verplanck Colvin.

Field and Forest. Three volumes, and current numbers to date.

Science Observer. One volume, and parts of current volume to date.

Psyche. Cambridge Entomological Club. Current volume to date.

Vermont Medical Journal. Vol. 1, parts 1 and 2.

Polytechnic Review. Current volume to date.

Introduction and Succession of Vertebrate Life in America, by Prof. Marsh. Pamphlet.

Of the Museum no statements need be made, except that it is poorly displayed for want of space in the Rooms of the State Board of Agriculture, and that a proper expansion and better display of the really valuable geological collection can not be made until after the building of the Capitol extension, when we hope to see it arranged in perfect order and supplemented by collections of the plants, insects and animals of Kansas.

E. A. POPENOE, Secretary.

NOTES ON GIANT'S CAUSEWAY AND FINGAL'S CAVE.

By Prof. C. D. Merrill, Washburn College, Topeka.

In the month of July, in company with an appreciative companion, it was my fortune to be at the little watering place of Portrush, about the middle of the line of the northern coast of Ireland. We took a jaunting car, with a good-natured Irishman as driver, and wheeling rapidly along a very picturesque road that overhangs the sea—the seething bottom of the Devil's Punch Bowl—past rounded hills and splintered cliffs still red with the marks of ancient fire—we came, after traversing eight miles, to that remarkable object of nature, the Giant's Causeway.

This part of the Irish coast is a succession of promontories and recessions, forming vast amphitheatres in the beetling cliffs, that from a height of three hundred feet look down upon the sea. Through one of these amphitheatres we descend to the shore. On the right, vertical in the side of the cliff, stands a group of basalt columns with an exposed front forty feet high, known as the Organ. A little further on at the extreme point of the right promontory are the Chimneys—three tall groups of columns forty-five feet high, and entirely separate from the surrounding rock. On all sides of these amphitheatres, for a distance of six or seven miles along the coast, basalt columns crop out from the cliffs in irregular masses. Standing in this semi-circle, as we turn toward the left the Causeway proper is before us, and unlike most of the great wonders of the world, it breaks upon the view without disappointment. Here is a sharp promontory three hundred feet high, cut down abruptly at the point, nearly to the level of the sea.

This promontory is composed of columns like those of the Causeway, but less perfect and more irregular in arrangement. At the base of this cliff a break in the columns is called the Giant's Gateway. This break forms the base of a triangle whose two sides meet at a distance of one hundred and twenty-five yards at the water level. These lines are the boundaries of the Causeway. As we stand on the base of the triangle then, we are twenty-five feet above the water, and have the whole Causeway before us in one view. Here are more than forty thousand columns of gray basalt standing in such close order that in most cases a knife-blade can not be inserted between them,—all so placed that the general slope from the base of the cliff to the level of the sea is as gradual and smooth as if formed for an actual highway. The length of the whole triangle is, at low tide, 125 yards.

We are told that, in all these forty thousand columns, "there is only one that is triangular—it stands in the east side of the grand Causeway. There are but three columns of nine sides, one in the honeycomb, and the other two near the triangular pillar. The total number of four and eight sides bears but a small proportion to the entire mass of pillars, of which it may be safely computed that ninety-nine out of a hundred have five, six or seven sides." Some are almost perfectly round, in others the angles of the face planes are extremely sharp and clean cut—in fact, most of the columns are beautifully defined in their sides and angles. The diameters of the pillars vary from eight to twenty-two inches—the average is about seventeen. The heads of the columns over which we walk are all either convex or concave. The concavity of a common sized column, eighteen inches in diameter, will hold nearly a pint of water—the cavities are, therefore, shallow. The tops of nearly all the columns are covered with a deposit of slime, which being often wetted by the sea, and dried by the sun, gives a dark and old appearance to the Causeway. This tendency to break in concave and convex forms proves a concretionary structure, and shows that each column is entirely separate from every other.

Dana states that the term basalt was early applied to a group of three rocks, viz: Melaphyre, Doleryte and Peridotyte, belonging to the series Hornblende and Pyroxene. Melaphyre and Peridotyte have nearly the same elements, texture and specific gravity as Doleryte, so we take the composition of the latter as that of the rock composing the Causeway. With a specific gravity of 2.75, there are as elements: Silica, 48.00; Alumina, 16.28; Protoxide of Iron, 15.55; Lime, 9.50; Magnesia, 3.85; Potash, 2.01; Soda, 2.01; Water, a fraction. A more popular analysis would be to say these pillars are composed of about one-half flinty earth, one-quarter iron, and one-quarter clay and lime. In rocks of concretionary structure like basalt, the tendency of the melted material is to concrete about centers. "Basaltic columns, then, are a result of this concretionary structure" (this grouping about centers) "and each column corresponds to a separate action. The size of the columns is determined by the consistency of the mass to be cooled; the thicker the mass, the slower the cooling and the larger the columns. The cracks separating the columns are due to contraction on cooling.

Such is the situation and the mechanical and chemical composition of the Giant's Causeway; but as we stand upon it and contemplate its wonderful formation, the mind is flooded with such questions as these: How far does it extend under the land and how far under the sea? How and when, and under what conditions, did it come into existence, and what is that mysterious power of nature than can thus transform the molten rock into forms of such magnitude and beauty? These and many like questions must remain but partially answered, but until they are answered, the Causeway

will stand an object of the highest interest to the inquiries of the common mind, as well as to those of geological science.

Let us now transfer ourselves for a moment to the island of Staffa, off the middle of the western coast of Scotland. It is eight miles west of the great island of Mull, and about forty from the proper coast of the mainland. Staffa is a mile and a half in circumference, and the surface elevated a hundred feet above the sea, is covered with rich grass that supports thirty cattle for the tenants of the Duke of Argyle. We land from the steamer in small boats, at the eastern side of the island, the only accessible place, and walk over the surface toward the southwest corner. Here we find the highest elevation—144 feet. On the rude wooden stairs built for the purpose, we descend the cliff and reach a range of broken basalt columns, exactly similar to, and hardly less grand than the Causeway of Ireland. Along this range of columns, we proceed 150 yards to the west, and, turning a sharp angle, stand at the entrance of Fingal's Cave. Here, springing out far above us, a stupendous gothic archway supports, at a clear height of seventy feet, an entablature of crushed, prismatic basalt, thirty feet in thickness. The entire front and inner parts of the cave are composed of range on range of magnificent columns, with beautiful joints and wondeful symmetry of form. The length of the cave within is 230 feet, the roof is of solid masses of basalt, the sides of huge pillars in their usual forms, the pavement of water in ceaseless motion.

The question now arises, what connection, if any, there is between these two similar geological formations, the Causeway and the Cave. One is on the north coast of Ireland, and sloping gently under the sea, points its main ridge northward, exactly toward the Island of Staffa. The other, off the west coast of Scotland, a hundred miles away, also slopes gently under the sea, sending its main ridge southward toward the Irish Causeway. Looking at the mountain lines of Great Britain and Ireland, we find their general trend is north and south. We find also that the rocky ridge forming Argyleshire—being interrupted by only sixteen miles of shallow water between the Mull of Cantire and the Irish coast—is continued southward by the mountains of Eastern Ireland. These basalt formations, then, are found in the slopes of a great mountain valley. We find conditions similar to these in the Valleys of Connecticut, of New South Wales, and of the Hudson river, and these places are famous for their dikes, ridges of basalt columns and trap rock formations. If, then, dikes are formed under such conditions, it seems fair to connect the formation of the Cave and the Causeway as two visible portions of a vast dike, whose hidden parts are under the land and the sea. The general statement, then, will be this. At a former period a fissure was opened by subterranean force along this mountain valley, extending itself from Staffa to the Irish coast. From this fissure vast quantities of molten rock poured upward, and, on reaching the surface, crystalized into its natural forms. That there are many oblique and horzontal columns may be explained by the natural action in the dike—the top of the molten mass, crystalizing into columns first, was pushed out and over by the liquid mass rising from below. Probably the phenomena of the origin of any small dike may apply to the origin of this greater one—it may be the very magnitude of the formation that deceives the investigator of its origin.

I give here the most common of the many legends among the Irish, accounting for the formation of the Giant's Causeway: The giant, Fin McCoul, was the champion of Ireland, and was angry at the boasting of a certain Scotch giant, who offered to give the Irish champion a beating, provided he could cross over to Ireland without getting wet. Thereupon Fin McCoul obtained permission of the king, and biult a causeway straight over

to the dwelling-place of the Scot. Upon this causeway the Scot crossed over to Ireland, and was badly beaten by Fin McCoul, who then generously invited the Scot to continue in Ireland. The invitation was accepted, for everybody knows that Scotland has ever been a hard place to get a living in, while Ireland was always the richest country in the world. May not this legend point to the former existence of the whole as parts of a causeway between Staffa and Ireland? It certainly indicates an old belief of the people in the existence of such a causeway.

I conclude these notes with one more thought on the formation of Fingal's Cave—a thought that occurred to me when surveying the ecclesiastical ruins of Iona, a thought of which I can not say whether it is original because peculiar, or peculiar because iriginal. The Island of Iona, nine miles southwest of Staffa, was one of the first seats of Christianity in Britain. St. Colomba, an Irish missionary, began religious foundations there in the fourth century. He was one of the Culdees, who preferred lonely and retired places. In this island are many fine old ruins of a cathedral, a chapel and nunnery, and some peculiar carved pillars called the Iona crosses. Of these crosses there were in the island, previous to the Reformation, about 360, marking the graves of kings, abbots and monks. These crosses semed to be as basalt, like the pillars of Fingal's Cave. Now while in Fingal's Cave, I was wondering how it was possible that the sides of the cave, as they are at present, could have ben formed by the forces of nature alone. For the pilars along the sides are broken out to the width of five or six feet, leaving their broken ends adhering to the crushed basalt of the roof, while the lower ends form a pathway by which one may traverse the length of the cave as in a side gallery of a church. It seems impossible that these columns should be thus broken by nature, and so when I saw the crosses on the adjacent island, the thought came at once, that they were the missing pillars of Fingal's Cave. Is it not possible that these hardy Christians pried out, as would be comparatively easy, the pillars along the sides of the cave, and made them into the crosses that once marked the graves of their dead? The number of broken columns in the cave I judged to be about equal to the number of the crosses—three hundred and sixty. Perhaps, then, the cave as it now stands is partially the work of man.

Possibly, too, it was used as a place of retreat or worship by the Culdees before they built their cathedral in Iona. It would certainly be a beautiful thought to the Christian mind, that the earliest songs and prayers of his faith went up to the Creator from this temple of His creation, which seems to me nobler than any yet raised by human hands.

I remember that just as we were entering the cave, fifty tourists in the farther end took up together the strains of the "Old Hundredth" hymn: and as the full notes went up along the great shadowy vault, and rolled back and forth multiplied into a sounding flood of music, it seemed to me that I had never heard a hymn of praise in so appropriate a place.

Then followed the strains of "God Save the Queen," so grateful to American ears as our national hymn. And there, as it were, in the very bosom of the earth, with the prismatic tints of blue and green and gold in the vault above answering back the beams of rising light reflecting from the waves below, with the boom of the sea, as it rolled its long surges up the watery aisles and hurled them thundering against the opposing wall, closed in about on every hand by the pillared forms of everlasting rock—what a place it was for the inculcations of loyalty to God and native land—what a place it was in which to read the story of the creation.

ON MASTODON REMAINS IN DOUGLAS COUNTY.

By J. Savage.

Upon the third Friday in June, 1877, two of my neighbors, W. W. Tweed and N. P. Deming, accompanied by Prof. D. H. Robinson of the State University, spent the day upon the Wakarusa, fishing. This stream is about forty miles in length, and for the last ten or twelve miles of its course runs nearly parallel to the Kansas river, only about six miles south of it.

These three fishermen spent most of the day southwest of Lawrence, upon the tract of land now owned by Judge S. O. Thacher. The day being rather warm and sultry, they sat down upon the shady banks of the stream to rest themselves. While reclining somewhat leisurely here, Mr. Tweed said to the other two that he had noticed a large bone projecting from the bank down near the water, just below where they were sitting. Whereupon, Mr. Deming arose, and going to the bone, hit it a kick and broke off a small fragment—enough to convince them that it was a real bone. This aroused their curiosity so much that they procured a spade and soon unearthed the entire bone, which proved to be the lower jaw of some very large animal. The jaw lay bottom up with the teeth downwards, and with the front end pointing into the bank, almost entirely embedded in blue clay. Prof. Robinson and others soon after wrote up the account of finding the jaw for the papers, describing it as a mastodon jaw. Its identity, however, was in dispute until the following winter, when Prof. B. F. Mudge went East and identified it as the Mastodon Ohioticus. This jaw has four large teeth in it, well preserved and in place, and altogether looks as though the animal to which it belonged had been dead but a few years. We are glad to state that it is now safe in the cabinet of our State University, but too frail to be transported for exhibition at our present meeting. During the fall of 1877, Prof. F. O. Marvin and the writer spent two days in exploring the banks of the Wakarusa, in order, if possible, to obtain some other portions of mastodon remains.

In this search we were unsuccessful as to finding more of the mastodon, but learned something concerning the formation of the bottom adjoining the creek, which may be interesting to relate in this connection.

The jaw was found in what was once the bottom of a fresh water lake or estuary, which extended for several miles both up and down the creek; its boundaries have not yet been determined, nor perhaps ever can be with exactness. That it extends out beneath the bottom lands adjoining, is proven by the many springs which issue from it in different localities up and down the stream, and it can be traced each way from where the jaw was found, some ten or twelve miles in extent. Beside the thick layer of muscle shells which line this ancient lake-bed, we find the trunks of old trees protruding, as well as small sandy concretions containing net-veined leaves within them. In addition to these layers of muscle shells, old trees and concretions, we also find bones of what appear to be the remains of the buffalo, antelope, elk, and some other animals as yet undetermined; but all in an unfossilized state. This goes to prove that the animals whose bones we find along the same horizon with the mastodon, and are not fossilized, di not live contemporaneously with the mastodon whose jaw was found fossilized. We conclude then, that the mastodon jaw, though not way-worn

at all, was washed into this old lake-bed after fossilization had taken place, and may be all of the animal that was preserved.

I might also add, that Mr. M. Sayler, during last summer, explored the banks of the Wakarusa for some ten or twelve miles by boat; his explorations only confirmed our own previously made, and added considerably to our previous collection of unfossilized bones.

This lake-bed in which the mastodon jaw was found is about twenty-five feet below the present surface of ground. Whatever fossil treasures are in this locality we can not now determine; but so many bones have already been found that we already speak of it as the Bone-bed of the Wakarusa.

A FOSSIL TUSK, FOUND IN FRANKLIN COUNTY.

By Prof. Wm. Wheeler, Ottawa.

Sometime during the spring or early summer of 1878, a farmer, living on Eight-Mile Creek, in Franklin county, observed a curious looking root or snag protruding from the bank of the creek; and upon examining it, he concluded that it must be the fossil tusk of some gigantic animal. He thereupon dug it from the bank, and took it to Ottawa, leaving it in the office of the Ottawa Republican. The writer of this examined the fossil at the time, but not being an expert in such matters, he did not give a decided opinion upon its character, but inclined to the opinion that it was petrified wood. A piece of the thing was sent, by the writer, to Prof. F. H. Snow, of the State University, who, after careful examination, pronounces it "fossil ivory." It is, therefore, without doubt, the tusk of a gigantic mastodon.

In taking the tusk from the gravelly bank in which it was buried, two or three feet of the larger end was broken off, and the smaller end, for perhaps three feet, was not procured. The part saved measured fifty inches in length, and six inches in diameter at the larger end, three and a half inches at the smaller end. The whole tusk must, therefore, have been ten or twelve feet long.

The accompanying diagram represents the appearance of the ends when sawed square off. The appearance is very much that of the end of a small log or root, with some of the lines of growth obliterated. At these apparent lines of growth the fossil splits into layers, varying in thickness from a quarter of an inch to an inch. These layers break into short pieces, which easily crumble into irregular fragments. The appearance of the substance of the fossil is very much like that of a bone that has been boiled in lye, in the process of soap making; and the consistency is very much that of soft-soap-stone. Between the layers there is a thin film of rust color, seemingly produced by oxyd of iron.

A few years ago the tooth of a mastodon was found near the mouth of the same creek, five or six miles below where this tusk was found. The rest of the skeleton is probably somewhere along the bed or banks of the creek.

NOTES ON THE ANTIQUITY OF MAN.

By Dr. A. H. Thompson, Topeka.

The question of the origin and the antiquity of man has been aptly named "the great question of the nineteenth century." Its paramount importance is at once acknowledged; and as science strides forward in every other department, we can not but wonder that this, the problem of the past of our own species, a question lying so near to us, has been so long hidden from us. But it seems that the time has come in these latter years, when scientific investigation and progress in this department will no longer be kept in abeyance, but that it must be carried into parallel and symmetric advancement with other branches of natural science. The promise of this is given in the unexampled activity of investigation and the progress made in discoveries within the last score of years, and the prospect of still more rapid advancement in the near future.

Our knowledge of the antiquity of man upon the earth has been advanced slowly on account of the difficulties and stupendous obstacles against which it was compelled to labor. The greatest of these, and that which more than all else has retarded its development, has been the thralldom of Bishop Usher's chronology. For centuries every discovery tending to the elucidation of the question, was made to fit this procrustean bed, and from this slavery the science has but barely escaped. Many things have contributed to the overturning of old ideas, and the unprejudiced reception of the new. Among the latter the most prominent are the great discoveries of human remains in the formations of preceding geological epochs, until in our day the question of the antiquity of man has become an almost purely geological problem. We have advanced so much in this knowledge that the oldest historic remains become but as the tale of yesterday in the comparative age of our species. We go back thousands of years, as in Assyria and Egypt, and find a developed civilization and the capability of making written records; and then beyond that we must see other thousands of years during which that civilization was developed. Buried cities are frequently discovered of whose origin or history we have no suspicion; yet the relics of human creation there found often indicate a high cultivation and advancement in the arts of civilized life. These too, we know, point to a long period of time during which these forgotten empires were developed, flourished and decayed. But we know further that all the remains of the oldest civilizations have had their origin during the current geological epoch, and that this epoch alone is older by a hundred fold than the most ancient civilized remains extant. We pass beyond the historic period and the unknown buried cities into the period of the remains of man as a savage, so-called, the primitive age. We pass first the iron, then the bronze period, then into the stone age. In this age we pass through the neolithic into the paleolithic period— the oldest and longest of all. In the stone age we find the beginning of our own geological epoch, and that this period laps into the quaternary—the pleistocene. In the caves and drifts of the quaternary we find man the contemporary and hunter of the reindeer, the cave bear and the mammoth, and the numerous other animals of the arctic, temperate and sub-tropical fauna, so-called, there found. But we pursue him still further and find the indications of his being in the pliocene, and the probability of finding him in the miocene. We find indeed that not only early post-glacial

but inter-glacial man is a fact scarcely to be questioned, and we see also faint rays streaming down to us from pre-glacial times, as slight indications are sighted of his pre-glacial existence.

M. Broca, in his presidental address before the French Association in 1877, gave the history of these advances in these words: "Some of the nations of antiquity boasted of great ages for their past history, * * but no actual date can be assigned for the commencement of the historic period, beyond six or seven thousand years. From history we might suppose that man is quite recent in his appearance on the globe, and much later than those geological phenomena which have modified the conditions of life, and, by the change of climates, also changed the floras and faunas. This hypothesis was accepted everywhere by geologists when Cuvier created the paleontological system, * * and who, though devoted to the idea of sudden cataclysms, understood the immense lapse of time represented by a geological period, and the comparative shortness of the historic period, and thus naturally believed that man had not appeared until long after the fossil animals. * * This idea became classical, and on all hands it was pronounced that the existence of fossil man was impossible. Many facts opposed to this opinion appeared, but they were met only with doubts and scorn. It was in vain that either in the floors of caverns or paleontological deposits, human bones mingled with those of animals of the quaternary age were discovered—systematic objections were always presented. * * Thus were cast aside the discoveries made in 1828 by Fournal of Narbonne, in the cavern of Bize; in 1829 by Christoe of Montpelier, in the caverns of the Gard—afterwards by Emilien Dunon and Dr. Pitore, in the caverns of the Gard and of the Herault; and by M. Auri Boul of Vienna, in the quaternary of lower Austria; the vast researches of Schenerling in the caverns of Liege, 1822, notably the Gluth of Elgin; the remarkable cranium of Mont Denise, found in 1844, by M. Ayward, and others. Facts of this nature in those days made no impression, however decisive they may appear to us. To overcome this opposition an overwhelming mass of evidence was required. It was necessary to prove the presence of man not only in the quaternary caverns and ossiferous periods, etc., but also in the soil of the great valleys in horizontal and undisturbed state still in situ. The extensive beds of sand and gravel deposited in the bottoms of existing valleys by the powerful streams of the quaternary age most often contain these conditions, and thus Boucher De Perthes, seeking the proofs for the existence of ancient man, discovered lying mingled with the bones of the rhinoceros and mammoth, the flint weapon used by man in his struggles with these monsters of another age, and the innumerable implements furnished by his hands to supply his wants. For a long time the assertions of Boucher De Perthes were not believed, his illusions were smiled at, and the dreamer was pitied. But from 1840 to 1858 he struggled against indifference and disbelief, only asking for the examination which was denied him, until in the latter year, when Falconer from England went to Abbeville to see and examine the sites explored and the rich collection of worked flints and fossil bones there found. Other English savants—Prestwich, Evans, Gilmore and Lyell—followed, and themselves made successful searches at different points in the valley of the Somme for implements. French savants in their turn arrived, and M. M. Gaudry, Pouchet and others, obtained with their own hands axes of worked flint from the quaternary deposits of the Somme. Perthes' facts were thus fully confirmed. Discussion was given them at the Society of Anthropology of Paris, the question was examined in all its aspects, and all hesitation removed. Fossil man had henceforth an established place in positive science. * * To the names already mentioned, history will add those

of Eberhardt of Wurtemburg, of Esper, of John Frere, who in the eighteenth century, before the classification of geological epochs, dug up human remains and worked flints, now recognized as belonging to the quaternary. Justice will be done to Jages, who in 1825 recognized the great antiquity of the Constadt skull, which was discovered upwards of a century earlier, and was for a long time considered apocryphal; but with due praise to those early workers, it is Boucher De Perthes who will receive the homage due the bold wrestler who maintained the final struggle and came off the victor.

"The year 1859 beheld the theory of the antiquity of man burst upon the scientific world with irresistible force. * * All Europe, geologists, anthropologists, archeologists, threw themselves into the work with startling energy. Only eighteen years have now elapsed, and never, perhaps, in so short a time has such a rich harvest been gathered. Who can forget those days of his life when, from the bowels of the earth, from the depth of caverns, sounded the voice of the past, and the fossil communities lived again. * * Boucher De Perthes had only lifted a corner of that mysterious veil which hides the origin of man, and had proved that man had existed throughout the quaternary epochs, that he had been in France the contemporary of the reindeer, and animals which now only exist elsewhere, and of the mammoth and other extinct animals. But was this all? And was not the human race yet more ancient? This last question presents itself at once, and even more important than the other, for each of the three periods of the tertiary age was of much greater duration than the quaternary. The researches concerning tertiary man include the discoveries of M. Desnoyers, near Chartres, and of Prof. Capellini, in many tertiary sites in Tuscany, which tend to establish the fact of the existence of man in the pliocene age; those of Abbe Bourgeois of Thenay, would carry back even to the miocene age—that is, to the middle tertiary—the existence of an intelligent being who could work flints, and could only be man. * * But rertiary man is yet only on the threshold of revival, and the evidence in his support requires more definite proof. * * Quaternary man, on the other hand, has now become classical. He has been found in most parts of Europe, and in many places in the New World. His weapons and implements have been found and preserved by hundreds of thousands. * * There are got materials from the earth of valleys in which the relative position of the strata is enough to mark their date; at others from deposits rich in natural flints, where quaternary man had established his workshops; here, in the rock shelter where he camped; there, in the caves in which he lived. In the cave dwelling places the finds have been most abundant, and we have been able to study even the details of the life of a tribe, the remains of repasts, the weapons for the chase and for fishing, the sewing implements, all the products of the flint worker, to which may be added at a certain period, handsome implements of bone and reindeer horn; then, the symbols of power, ornaments, objects of commerce, the works of artists, sometimes rude and uncivilized, at other times full of grace, motion and truth, represented by engraving or sculpture, the animals hunted in those days—the bull, horse, aurochs, reindeer, the great cave bear, and the gigantic mammoth. Quaternary man has his chronology, not one of years or periods, like ours, but of archeological and paleontological periods, vast spaces of time, taking date according to the various fossil species which predominated unceasing around him, and according to the different types of implements marking the gradual evolution of his work. He has his history also, not indeed political, but anthropological; not that of peoples and chiefs who became celebrated, but that of races who supplanted and succeeded one another on the same soil."

So much for quaternary man, but what of a still older than he? We have seen that intimations have been discovered of tertiary man—that pliocene man is a probability and miocene man a possibility. In pursuing the subject further, we observe that on May 22, 1877, a conference of the Anthropological Institute of Great Britain was held upon the subject of the present state of the question of the antiquity of man in England. Mr. John Evans, F. R. S., the president, in his opening remarks, said, "the question laid equally in the domain of, first, the archeologist (who should decide upon the genuineness of articles of human workmanship); 2nd, the anthropologist (who should decide upon human bones), and 3rd, the geologist (who should decide upon the geological age of the deposits), and that great care and caution should be received as to the acceptance of evidence, and that sources of error should be carefully watched for and eliminated." He then alluded to the discoveries, "first, of that at Thenay, of implements which are attributed to a miocene age; to that of the bones of the whale, near Sienna, which are regarded as having been cut by man. There is doubt as to whether this is pliocene or later: of a human skull in a bed regarded as pliocene. There is doubt as to this—especially as a neolithic-appearing spear-head was found in company with it; to that near Lake Zurich of cut staves of wood and other staves with shavings around them in the interglacial lignite; and to others. In these discoveries, the whole question turns upon the geological age of the deposits. There is but little doubt that if the quaternary man of Britain had attained the ability to fabricate what he has left, and to subsist in such a climate—for these people may have been colonists or wanderers from the original stock whose home was under a more favored clime—that remains of yet earlier members of the human race will eventually be found."

A paper was read by Prof. Boyd Dawkins upon the "Evidence of the Pleistocene Caves of Great Britain," in which he said that "it has been recently urged that all paleolithic deposits both in caves and river beds are of pre- and inter-glacial age; that is, that they date back to an antiquity vastly more remote than that post-glacial period to which they have been referred by Lyell, Prestwich, Evans and others. The argument is based on those conditions of life which are said to be inconsistent with those of post-glacial times. * * * The antiquity of man can not be measured by the chronology of the historian, but by the sequence of those physical and biological changes which are so familiar to the geologist. * * * The nature of the evidence of the caves may be best estimated by taking a particular case; say that of the paleolithic caves of Cresswell Crags. * * * On the floor of these caves was, first, a layer of light-colored sand without fossils (the result of the decomposition of the rock below), next, the lower ossiferous strata, consisting of red sand and clay, averaging three feet in thickness and containing numerous stones and fragments of fossil bones and teeth. These latter are all scored and marked by teeth—the prey of hyenas, and dragged into these dens piecemeal, and well scattered through the sand and clay as the result of the occasional flooding of the caves by the stream, which was then near the entrance, although twenty feet below at the present time. These bones belong to the lion, spotted hyena, reindeer, Irish elk, bison, rhinoceros, mammoth, and some other animals. To these must be added man, who left a few rounded quartzite pebbles and flakes of quartzite, of the rudest and roughest sort. The whole group of caves points out that savages of a low order visited the district from time to time. Above the red sand was a fine red loam, sometimes in the upper part or limestone breccia. In this were fragments of bone, some gnawed by hyenas, others

broken and scratched by man and associated with charcoal and burnt bone, and implements of quartzite flint and ironstone, of types well known in England and Europe. Implements of flint and bone were very numerous of various kinds, and the incised figure of a horse, well drawn, on a rounded and polished fragment of rib. The species of animals represented were more numerous than in the lower bed. Above this bed was a layer of stalagmite ranging from one foot to a few inches in thickness. The human occupation of these caves consisted of three distinct periods: first, the rough quartzite period; then the quartzite and flint; then the flint and bone—the period of the artistic drawing and the elaborately worked implements. These three stages indicate a distinct progress in art among the cave-dwellers. * * * The mixed fauna universally found in British caves, can be explained better on the principle of seasonal migrations, than glacial aeons." * * He concludes also, "that paleolithic man belongs to the northern group of animals, being associated most frequently with the reindeer and the northern fauna—that of the late pleistocene. And also that some of the northern caves may have been older than post-glacial, which shielded the paleolithic hunter." He then concludes, "that according to the evidence of the associated mammalia, man was probably in Europe while the ice covered large tracts in England, North Germany and Scandinavia, or in pre-glacial and inter-glacial times, and he was an inhabitant of the Denbigshire caves after the ice of the second ice period had passed away from that region."

Prof. T. M. Hughes spoke of the "Evidences afforded by the Gravels and Brick-earth of the East Anglican district, in which remains of man before the close of the glacial period have recently been found. These deposits are post-tertiary boulder clays and gravels, and he concludes that man appeared upon the scene early in the post-glacial period." Mr. R. H. Tiddeman spoke of the "Age of the Hyena-bed, Victoria Cave, Settle, and its relation to the question of the antiquity of man"—in regard to the very remarkable human fibula found therein, concerning which there was so much discussion. Animal bones cut with human implements were also found in this bed. In summing up he says: "Even supposing that we had never found traces of man in Victoria Cave in the older pre-glacial beds, his great antiquity would be there fairly proved. A set of animals known to exist with man elsewhere, is there shown to have lived before an age of great land glaciation. That ancient fauna lived in the south of England and the eastern counties upon a land surface covered with the vestiges of a still older and more extensive glaciation, the traces of which have been swept away in the north by that later glaciation. This glacial period, which I consider to have been later than man's introduction into Europe, appears to be the same which spread over the whole of Scotland and perhaps of Ireland, with a sheet or sheets of land ice." In the discussions which followed, Prof. Prestwich said: "Evidence on this subject is afforded by the boulder clay which reaches as far north as London. That represents the glacial period." The post-glacial he considers "to be subsequent to the period of the deposit of the boulder clay. * * It is in the drift and gravel of the valleys excavated in this boulder clay that paleolithic implements have been so commonly found; consequently, it is clear that in that area man is of post-glacial age. * * In the south of England there is evidence that both areas of the land were inhabited by animals likely to serve as the food of man, previous to the boulder-clay period, and that man probably existed before that period in the north of England. * * He believes, with Mr. Tiddeman, that the evidence of Victoria Cave rather tends to show that it is pre-glacial. * * He considers that the data for

carrying man back to the boulder-clay period, is an account audited and passed, and he has good reason to believe, from his own observations, that man was pre-glacial in the north of France."

Prof. Virchow, of Berlin, delivered an address before the German Association of 1877, in which he says of this question: "At this moment Anthropology studies the question of fossil man. From man in the present 'period of creation' we have descended to the quaternary period, where, as Cuvier maintained with the greatest confidence, man never existed at all. Nowadays, quaternary man is a generally accepted fact; is no longer a problem, but a real doctrine. But tertiary man is a problem—of course a problem which is already in a stage of material discussion. There are objects already about which discussions are going on as to whether they may be admitted as proofs for the existence of man in the tertiary period. * * Even men who, like Abbe Bourgeois, are decided ecclesiastics, are convinced that man has lived during the tertiary period; for them tertiary man is already a doctrine. For us, who are of a more critical nature, tertiary man is a problem, but, as we must acknowledge, a problem worthy of discussion. Let us, therefore, for the present, remain at quaternary man, whom we really do find. * * It may indeed be that tertiary man has existed in Greenland or Demaria, and will again be brought to light from under the ground somewhere or other."

At the last meeting of the British Association, Dublin, August, 1878, Prof. John Evans, in his address before the Geological section, said: "One of the questions which has of late occupied geologists, is the age to be assigned to the implement-bearing beds of the paleolithic age in England. Dr. James Geikie has said that for the most part they belong to an inter-glacial episode towards the close of the glacial period, and regards it as certain that no paleolithic bed can be shown to belong to a more recent date than the mild area that preceded the last great submergence. His follower, Mr. Skertchly, records the finding of paleolithic implements in no less than three inter-glacial beds, each underlying boulder clays of different ages and somewhat different characters—the Hessle, the purple, and the chalky boulder clay. * * I have always maintained the probability of evidence being found of the existence of man at an earlier period than that of the post-glacial or quaternary river gravels. * * In the present state of our knowledge, I do not feel confident that the evidence has arrived at a satisfactory stage of certainty." Before the Biological section, Prof. Huxley delivered a short address, in which he referred to the question of the antiquity of man as follows: "Great progress has been made in the last ten years in the direction of the discovery of man in a fossil state. My memory goes back to the time when anybody who broached the notion of the existence of fossil man would have been laughed at. It was held to be a canon of paleontology, that man could not exist in a fossil state. * * But it is now beyond all question that man—an intelligent man—existed at times when the whole physical conformation of the country was totally different from that which characterizes it now. Whether the evidence we now possess justifies us in going back further, or not—that we can get back as far as the epoch of the drift is, I think, beyond any rational question or doubt; that may be regarded as something settled—but when it comes to a question as to the evidence of tracing back man further than that—and recollect, the drift is only the scum of the earth's surface—I must confess that to my mind the evidence is of a very dubious character."

OZONE IN KANSAS ATMOSPHERE.

By Prof. W. K. Kedzie.

At the eighth annual meeting of this Academy, I had the pleasure of presenting a preliminary paper upon the occurrence of ozone in the atmosphere of Kansas. At the time of the presentation of that first paper, observations upon the subject had extended over a few months only; but even for this short period the results obtained were very striking, and compared very favorably with similar series of observations in Eastern States, both as to the constancy and amount of this important element of pure air. The results now submitted are those obtained from much more extended observation, for two years past, at various stations through the State.

The vital facts of the nature of ozone, as given at length in that first paper, may be briefly summed up as follows: 1st. That ozone was discovered by Schonbein, of Basle, in 1840, and that it is a condensed allotropic form of oxygen, having the formula O_3, and the equivalent 48. 2d. That it is produced in our atmosphere:—A, By electricity, both by lightning and by silent discharges; B, By all processes of oxidation, whether by rapid combustion or slow decay; C, By the evaporation of large bodies of water; D, By the process of vegetable growth, in which carbonic acid is decomposed in the leaf cells of the plants, the carbon retained and the oxygen thrown out again, always commingled with a trace of ozone. 3d. It was also shown that as rapidly as the ozone is produced in our atmosphere it is consumed again in the oxidation of all decaying animal and vegetable matter; by which means the air around us is maintained pure and free from all the offensive and poisonous products of decay. Hence, that around large cities, where decaying organic matter is constantly accumulating, ozone is only found in minute traces, while in the free air of the country it frequently exists in very appreciable quantities. It is also more abundant in winter than in summer, as during cold weather all process of decay and oxidation, by which ozone is consumed, are at a standstill. Generally, too, ozone is more abundant during the night than through the day, though this rule is by no means invariable, and during warm weather the condition is reversed altogether. 4th. It was finally shown from comparative records embracing the months from January to August, 1875, that the indications of ozone are much more abundant and strongly marked in the atmosphere of Kansas than in that of many of the States further east.

Since the presentation of this first paper, no further investigations have thrown any new light upon the general nature of ozone, except some exceedingly interesting results recently obtained by M. Berthelot, and presented by him in an article in the February number of the "Annales de Chimie et de Physique," for the present year. M. Berthelot has, by a number of very beautiful experiments, here shown that whenever ozone is formed by the action of the electric current upon oxygen, heat is absorbed; which heat is given out again when the ozone expends itself in the process of oxidation of other bodies. This fact, it is claimed by Berthelot, explains its superior activity to that of ordinary oxygen.

For the purpose of more fully investigating the occurrence of ozone in the atmosphere of Kansas, it was proposed that to any member of this Academy who would lend his assistance in conducting carefully recorded

observations there would be furnished gratis, blanks, test paper and color scales. This offer met with a most generous response, not only from members of this society, but from many other interested observers in distant parts of the United States. I have been under special obligation, the past year, to the kind assistance of the following gentlemen: Mr. B. B. Smyth, of Ellinwood, Barton county; Prof. John B. Dunbar, of Washburn College; Dr. A. H. Thompson, of Topeka; Messrs. J. H. Long and W. H. Carruth, of Lawrence; and L'Abbe Victor A. Huart, of the Seminary of Chicoutimi, Canada. Correspondence has also been opened with other observers too numerous to be enumerated here. The State Medical Society of Kansas was also, at the outset, quite disposed to lend its assistance in prosecuting this investigation, until some of its officers conceived the erroneous idea that the matter had already been made the subject of a report by the American Medical Association, and, of course, to further discuss any problem upon which so august a body had already passed, was quite out of the question! That such an impressian was entirely unfounded is evident from the following letter:

Philadelphia, October 6, 1876.

Prof. Wm. K. Kedzie,

Dear Sir: The only consideration of Ozone is an attempt to have its amount in the atmosphere noted and published by the Signal Service Bureau. This was a resolution attached to a report in 1875, by Dr. N. S. Davis, of Chicago.

Truly yours,

Wm. B. Atkinson,

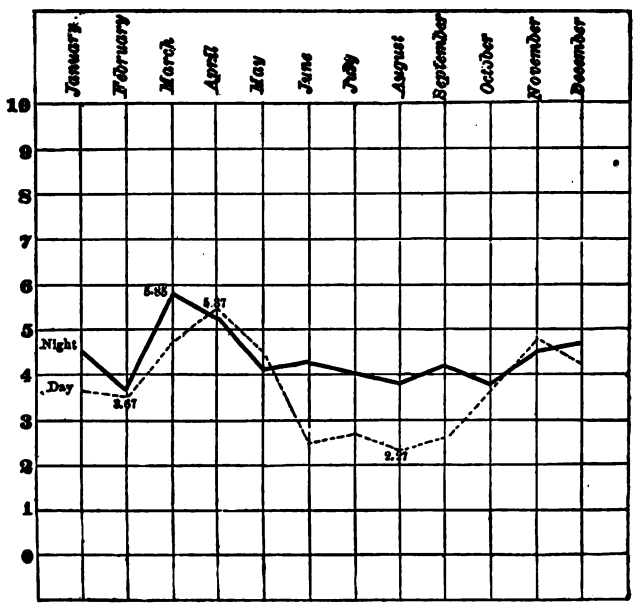
Permanent Secretary American Medical Association.

The doctors of the State need therefore have had no fear that in giving this matter attention, they would have been guilty of rehearsing an old subject. The test adopted in our observations, has been that known as the "Iodized Starch Paper" test, devised by Schonbein. Ten parts of starch are boiled in 200 parts of distilled water, to which, when cold, one part of potassium iodide is added. This is applied with a fine water brush to strips of unsized paper, which must be dried and preserved in the dark. When small strips of this paper are exposed to the atmosphere, if ozone be present, it will at once decompose the potassium iodide, setting free the iodine, which in turn combines with the starch, forming an intensely blue compound, at once apparent upon plunging the paper into water. The degree to which the paper is colored thus affords a very fair evidence of the quantity of ozone present in the atmosphere at that time; and may be recorded by comparing it with the color scale,—a scale of color bands upon paper, numbered from one to ten, and varying from the faintest to the deepest blue. The number of the color band to which the paper most nearly corresponds, is then entered in the record as the result of that observation. It is important that the test paper should be exposed to the air in a sheltered situation, protected both from strong wind and from direct sunlight, though freely exposed to the air and to diffused daylight. This color test of Schonbein is very far from being perfectly satisfactory in its operation or results. It is arbitrary, and indicates only the relative quantity of ozone present in the atmosphere; but it possesses the great advantages of being simple and easily comprehended, and is undoubtedly by far the best for use among general observers. Two series of observations have been conducted: First, the "Day observation," in which the paper is exposed from seven A. M. to two P. M. Second, the "Night observation," embracing an

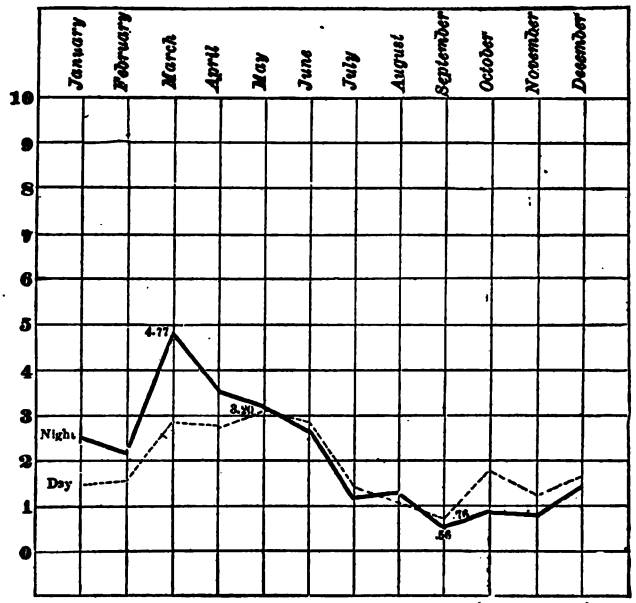
exposure from nine P. M. to seven A. M. The results of these observations have been recorded on blanks printed for the purpose, which have been regularly forwarded to me at the close of each month, the results being carefully tabulated. I have been under many obligations to Dr. H. B. Baker, Secretary of the Michigan State Board of Health, for the loan of similar records of observations taken at typical stations in that State. A comparison of these records results, as already stated, very favorably to the atmosphere of Kansas, both in the amount of ozone present, but especially in the high averages of the spring and summer months. These changes in the quantity of atmospheric ozone, during the different seasons of the year, nowhere appear so strikingly as when presented in diagrams. For the purpose of exhibiting these changes, I have constructed a diagram for four of the Kansas stations, in which, by a broken dotted line for the "Day observations," and a dark line for the "Night observations," the variations in amount of ozone in our atmosphere are vividly shown for each month throughout the year.

These diagrams show finely the general characteristics of ozone records, viz: the superiority of the night observations over those for the day, except during the warm summer months, when the condition is usually reversed; and the gradual fall of the quantities registered, from a high mean during the winter months to a comparatively low condition during summer, followed by a rise again with the approach of the succeeding winter. But the important feature already mentioned in the relatively large quantity of ozone indicated by some of our stations during the spring and summer months, is shown with especial prominence on comparing these diagrams with the records of Eastern stations. Each of these diagrams will well repay individual attention and study. The observations at Law-

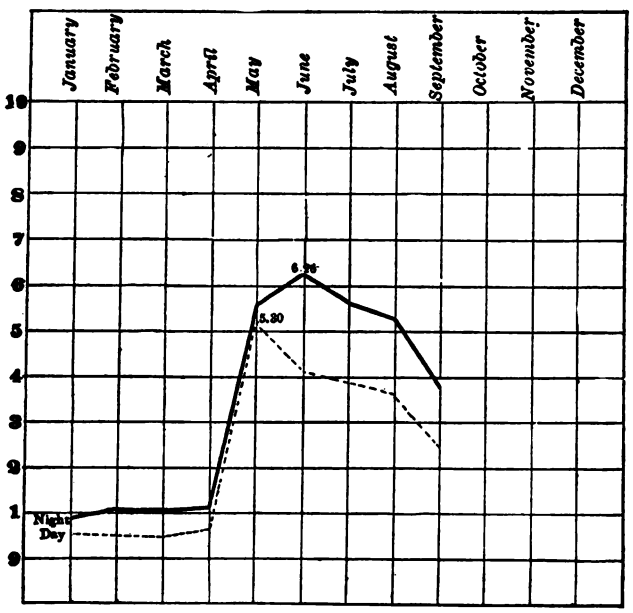
1877 ELLINWOOD 1876



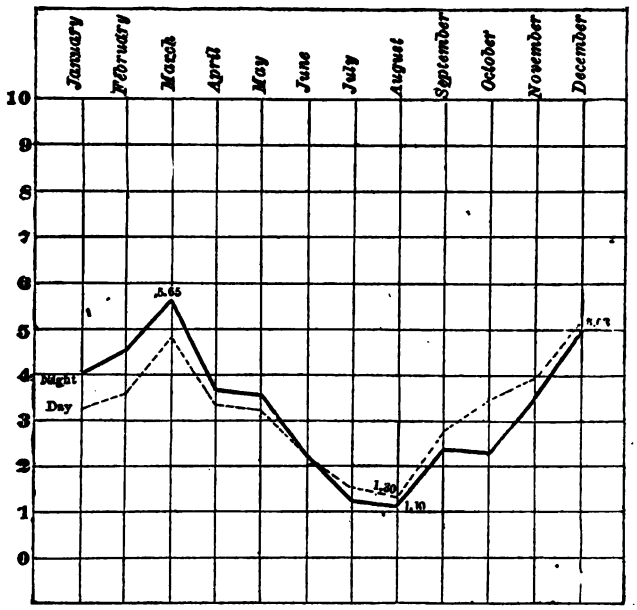
1876 LAWRENCE 1876



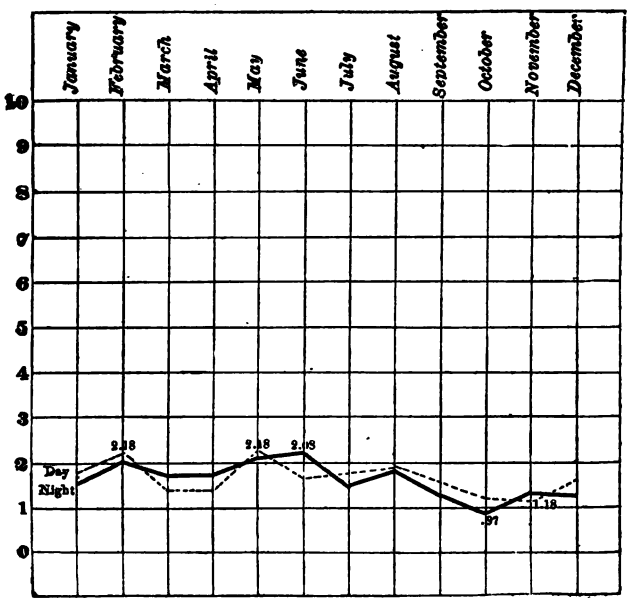
1877 LAWRENCE 1877



1876 MANHATTAN 1876



1877 TOPEKA 1876



coloration. The same result was obtained when a slip was exposed in the same manner between tightly sealed plates of glass. But when the glass was cracked, to allow the access of atmospheric oxygen in the presence of sunlight, the paper slip became perceptibly colored in a few hours. Thus is suggested a very interesting explanation of the well-known importance of the access of an abundance of bright sunshine, for pure air and good health within our homes. All these fragmentary facts show what a fascinating field for study and investigation lies within our easy reach; and when we add to all this the peculiar importance which attaches to this subject in our own State, our attention is awakened with redoubled interest. These carefully recorded observations in progress for the two years past have established beyond a doubt, the existence of a liberal quantity of ozone in Kansas atmosphere. The universally healthful character of the climate of the State, is so widely known a fact as to need no comment here. And in addition to our almost absolute freedom from epidemic diseases of every character, our State is just now attracting very general attention as a desirable resort for consumptive patients. Sufferers unable to endure the rare atmosphere of the higher regions of Colorado, now frequently find returning health by a protracted residence in Kansas. Has the ozone of our atmosphere any connection with this fact ? is an inquiry not infrequently addressed me by interested physicians from the East—to whom a satisfactory answer can be given only after long study and extended observation. In view of all the interesting features of this attractive theme, I can conceive of no more promising a subject of study than this of the offices of the ozone of our atmosphere in health and disease. Such an investigation may not, to be sure, either lighten our taxes or increase the value of our farm products. But it will be the means of revealing to us more fully an accurate knowledge of the wonderful resources with which nature has endowed us as a State; upon which, after all, rests the foundation stone of our material prosperity.

ON SOUND TRANSMISSION BY ELECTRICITY.

By Prof. J. T. Lovewell, Washburn College, Topeka.

Two years ago a Boston teacher of vocal culture astonished the world by exhibiting at Philadelphia an instrument by which a person, talking, singing or making any sound at one extremity of an electric circuit, might have the same words and tones faithfully reproduced at the other extremity.

At that time few people knew that this subtle agent, electricity, could be employed in the transmission of sound, though this thing had been done many years previously.

In 1837, Prof. Chas. Grafton Page, for many years an Examiner in the Patent Office, utilizing Prof. Henry's discoveries, succeeded in producing what he termed "galvanic music." This phenomenon at once attracted the attention of the scientific men, and, among others, the French electrician, De la Rive, investigated the subject with great care in 1843. Nothing came of these researches, except to add another laboratory experiment illustrating the physical principles of electricity.

In all these cases the sound transmitted was first produced by the

was the intention in organizing these series of observations, to study and record with great care all phenomena in connection with ozone which might in any manner assist us in ascertaining its relations, if any exist, to health and disease. Observers were requested to specially notice and record "any apparent connection between the abundance or deficiency of ozone, and the prevalence or absence of any given disease; or any influence observed in modifying the types of such diseases." But it is quite needless to state that the failure of promised co-operation has prevented any investigation of this very interesting question, which eminent medical authorities in Eastern States have considered well worth their attention and study. Until an abundance of such data shall accumulate, any attempt at discussion of the relations of ozone to health and disease, will prove, from necessity, fruitless and unsatisfactory. There are not wanting, to be sure, persons whose opinions upon this question are very positive and very emphatically expressed—as those of the superficially minded usually are. Such may be readily classified under two heads. First, those who look upon ozone as nature's great specific—the universal cure for all ills to which frail human flesh is heir. Second, those, who after a slight and trivial examination of the subject, have failed to arrive at any conclusions satisfactory to themselves, and hence ridicule the suspected relations of ozone to health and disease, as visionary hullucinations. The testimony of both these classes of "thinkers," is of about equal worth. The arguments of both smack strongly of "personal conviction;" their conclusions are wholly without any foundation in fact, and hence are utterly and completely valueless. What is wanted to-day, above all things else, is calm, unprejudiced; unimpassioned observation and study of accumulated facts. Our present knowledge of the relations of ozone to the laws of health, is, at best, of very general nature only. We know that while ozone is a constant and normal ingredient of pure air, that the amount present at any one time is always very minute—never over one part in 450,000 by weight. On the other hand, ozone can not exist in foul air, laden with organic effluvia, and there are many observations which have shown either its entire absence or presence in very minute quantity during the prevalence of certain types of epidemics, though its relations to zymotic diseases is by no means yet clearly established. Ozone is also a most vigorous disinfectant; and one of the most simple and beautiful methods recommended of purifying the air of a sick room, is by use of the well-known flameless or "aphlogistic" lamp, which in its slow combustion, continuously generates a small supply or ozone. This lamp is easily constructed, by placing a small piece of platinum sponge, or a small coil of fine platinum wire even, upon the wick of a common alcohol lamp, partially surrounding it with the fibers of the wick; lighting the lamp and then cautiously blowing it out, when the metallic mass will continue glowing at a red heat for several hours from the slow combustion of the alcohol, in which process a minute quantity of ozone is liberated. On the other hand, it is well known that air containing an excess of ozone can not be respired, and is fatal to animal life. When present in much greater than average quantity in our atmosphere, ozone almost invariably produces violent bronchial and catarrhal troubles among persons susceptible to these difficulties. This coincidence I have noticed repeatedly in this State. In an exceedingly interesting address delivered in 1875, by the President of the State Medical Society of Michigan, some very interesting experiments are given, tending to prove that sunlight itself, acting on organic matter in the presence of free oxygen, is a powerful generator of ozone. Slips of iodized paper were exposed to bright sunlight in jars of carbonic acid, hydrogen and nitrogen gases for days, without undergoing the slightest

coloration. The same result was obtained when a slip was exposed in the same manner between tightly sealed plates of glass. But when the glass was cracked, to allow the access of atmospheric oxygen in the presence of sunlight, the paper slip became perceptibly colored in a few hours. Thus is suggested a very interesting explanation of the well-known importance of the access of an abundance of bright sunshine, for pure air and good health within our homes. All these fragmentary facts show what a fascinating field for study and investigation lies within our easy reach; and when we add to all this the peculiar importance which attaches to this subject in our own State, our attention is awakened with redoubled interest. These carefully recorded observations in progress for the two years past have established beyond a doubt, the existence of a liberal quantity of ozone in Kansas atmosphere. The universally healthful character of the climate of the State, is so widely known a fact as to need no comment here. And in addition to our almost absolute freedom from epidemic diseases of every character, our State is just now attracting very general attention as a desirable resort for consumptive patients. Sufferers unable to endure the rare atmosphere of the higher regions of Colorado, now frequently find returning health by a protracted residence in Kansas. Has the ozone of our atmosphere any connection with this fact ? is an inquiry not infrequently addressed me by interested physicians from the East—to whom a satisfactory answer can be given only after long study and extended observation. In view of all the interesting features of this attractive theme, I can conceive of no more promising a subject of study than this of the offices of the ozone of our atmosphere in health and disease. Such an investigation may not, to be sure, either lighten our taxes or increase the value of our farm products. But it will be the means of revealing to us more fully an accurate knowledge of the wonderful resources with which nature has endowed us as a State; upon which, after all, rests the foundation stone of our material prosperity.

ON SOUND TRANSMISSION BY ELECTRICITY.

By Prof. J. T. Lovewell, Washburn College, Topeka.

Two years ago a Boston teacher of vocal culture astonished the world by exhibiting at Philadelphia an instrument by which a person, talking, singing or making any sound at one extremity of an electric circuit, might have the same words and tones faithfully reproduced at the other extremity.

At that time few people knew that this subtle agent, electricity, could be employed in the transmission of sound, though this thing had been done many years previously.

In 1837, Prof. Chas. Grafton Page, for many years an Examiner in the Patent Office, utilizing Prof. Henry's discoveries, succeeded in producing what he termed "galvanic music." This phenomenon at once attracted the attention of the scientific men, and, among others, the French electrician, De la Rive, investigated the subject with great care in 1843. Nothing came of these researches, except to add another laboratory experiment illustrating the physical principles of electricity.

In all these cases the sound transmitted was first produced by the

vibrating spring of an electric coil which opened and closed an electric circuit; and the same tone was reproduced by an electro-magnet through which the interrupted current passed, and whose vibrations corresponded with those of the spring of the induction coil.

There was, following this, more or less crude speculation on the possibilities of transmission of sound by electricity, but nothing better than De la Rive's experiments is recorded till 1861. At that time Reiss, teacher of a school at Friedrichsdorf, near Homberg, entered the field of investigation with the true German spirit. His first telephone was made with a beer barrel, the bung of which was pierced with a conical hole, and over the smaller end the skin of a German sausage was stretched. Another tubular opening into the barrel allowed this membrane to be put into vibration by tones of the voice. These vibrations, by suitable mechanism, opened and closed an electric circuit, and the interrupted current passed through an electro-magnet properly mounted on a box for strengthening the sound.

The German pedagogue still flourishes, and has made many improvements in his original telephone—some of quite recent date.

A writer in the Polytechnisches Notizblatt, in 1863, says, that not only tones, but words, could be communicated by Reiss' telephone, if such as heard frequently; and in 1865, Yeates, an instrument maker of Dublin, introduced a modification of Reiss' instruments that was said to transmit words well, by members of the Dublin Philosophical Society. Reiss named his invention a telephone, a name that had then been in use many years, and was applicable to all instruments for transmitting sound to a distance. Reiss suggested that this kind of sound transmission might be the basis of improvements in telegraphy, but no practical applications were made, and telephones were merely philosophical toys until Bell's work culminated in 1876.

Till that date our best text books, if allusion was made to it at all, dispatched the subject of electrical transmission of sounds in a paragraph. Since then, the progress of the science has been simply wonderful, for we may surely call telephony a science bringing forth several volumes in two years, and being the subject of articles innumerable in all classes of journals, and the topic of inquiry and curiosity everywhere. I have no time to pursue my theme historically, any further, nor do I wish to enter on the disputed question of priority.

A discussion of principles and applications is more worthy the attention of the Academy.

We may divide electric telephones into three classes: 1st. Those already described, where the vibrations of a reed, or membrane, cause interruptions of an electric circuit, thus sending intermittent currents to a distant station. These currents have the same frequency as the pulsations of the sound-wave that caused the interruptions, and will produce in the electro-magnet pulsations of like frequency. We thus get a tone of the same pitch as the original note which is sung by the voice or emitted by the vibrating reed. The quality of the tone—its timbre, will depend on the kind of mounting given to the electro-magnet. The most elaborate telephone of this class, yet constructed, is that made by Prof. Gray, of Chicago. For the original tones he used reeds of different pitch, vibrated by electric influence which was controlled by keys like those of a piano. At the receiving end he had an ingenious and complicated apparatus for reinforcing the sound. It was Prof. Gray who gained such wide celibrity by his telephonic concerts, in the first of which, music in Chicago was reproduced in Milwaukee, greatly to the surprise and delight of a large audience.

Prof. Gray, as electrician to a telegraph company, naturally sought to utilize the principles of his musical telephone in multiplex telegraphy, and has been measurably successful, though the time does not seem ripe yet for its universal adoption. Aside from its novelty, the music from this sort of telephone has no special charm. It is apt to sound weird and doleful, and reminds one of hand organs, such as are ground by old beggar-women, to attract notice and sympathy, sitting with their starved children beside a gutter. As a musical instrument it is not a success, as Artemus would have said.

Telephones of the second class, of which Bell's instruments were the precursors and type, soon gained popular attention, not only by their interest but by their practical applications also. Bell's researches were begun and carried forward in the true spirit of the philosopher, and though the goal reached was not at first aimed at, he exhibited true genius in seizing the clue offered, and following it out so faithfully. Following in the footsteps of a father somewhat famous as the author of "Visible Speech," Bell was seeking some way to make the sound-wave give a permanent, visible and legible record of itself. He found the manometric capsule of Konig, and the phomantograph of Leon Scott, unsuited to his purpose, and sought to improve the latter by making it after the model of the human ear. A friend suggested the use of the ear itself, and the success of their experiments with this novel apparatus gave the clue that Bell needed. If, thought he, a membrane like the tympanum of the ear can move a series of bones, relatively of large size, why will not a larger membrane move a magnet that will vary the intensity of the electric current in waves corresponding to the sound waves? He had before sought in vain to reach a similar result by the means of sympathetic vibrations, but his new effort with the vibrating plate was crowned with triumphant success.

I have indulged in this sketch of the genesis of the vibrating plate since it is to be regarded as the fundamental idea of the second class of telephones, and one of the most suggestive and fruitful discoveries of the age. Three forms of instruments were exhibited at the Centennial, Philadelphia. The principle in each was the same, and in construction there was a battery sending a continuous current between the receiving and sending stations. At each of these places it passed through coils of fine insulated wire, having as a core a piece of soft iron. This of course became a magnet, and directly in front of it, distant say one-thirty-second of an inch, was fixed a thin plate of iron. A suitable mouth piece before the plate converged the sound upon it and gave the vibrations. It must be remembered that the iron plate is in the magnetic field and has become a magnet. Its vibration, therefore, according to well-known electrical principles, caused electric pulsations to pass through the coil of wire, the intensity and direction of the currents being proportional to the velocity and direction of the moving plate. A vibrating plate, according to well-known acoustic laws, has property of dividing into nodes and ventres so that it can harmonize with any sound-wave, however complex. Thus it results that the plate copies the sound-wave and the electric pulsations copy the plate. Now these pulsations passing through the helix at the receiving station, change the magnetic state of its iron core, and consequently the attractive force of the latter on the plate in front, just in proportion to the frequency, intensity and direction of those pulsations. A vibration thereupon ensues which copies in all its minute detail the original vibration of the first plate and sound-wave. This is transmitted to the air and thence to the ear. Thus we have a sound-wave which by instrumentality of a magnetic plate is

copied by an electric wave, and this in turn is retranslated into a similar sound-wave. The original sound dies like any other sound, but its photograph, as it were, has been copied in a more subtile medium than air, and so it lives and moves and is born again.

In a few months after its exhibition at Philadelphia, this invention had received such development at the hands of Mr. Bell that subsequent progress has been slow, and the most recent telephones show little improvement over those made a year ago. Bell found that the size and thickness of the vibrating plate, likewise the strength of the battery, could be altered in pretty wide limits without materially changing the loudness of the tones at the receiving station. In his experiments he varied the plate from one inch to two feet in diameter, and from one-sixty-fourth to three- eighths of an inch thick. Between these limits he found the articulation perfect, though if too small or too thin the tones had a nasal character, while it sounded like talking into a barrel if the plates were too thick or too broad. Likewise in the battery, he left off one cell after another, until finally all were removed, and still he could talk through the instrument. This was due to residual magnetism as he afterward found, but it led to the abandonment of batteries and the substitution of permanent magnets for the iron cores. This is the form in which the Bell telephone is now used, with no battery and no continuous current, being purely magneto-electric in its principle of action. It must be evident, prima facie, that such a telephone can only talk in low tones. Only a small part of the original sound impulse can be changed into electricity, and this in turn can deliver but a small fraction of its force to the ear of the listener. It has been, therefore, from the first, a desideratum to increase the loudness of telephone messages. In quality they were all that could be desired, but the still small voice was hard to be distinguished by unpracticed ears. Hence the long continued experiments of Prof. Bell alluded to. It was found that if an increase was attempted by shouting the original message, the quality of that delivered was much impaired. The sounds, though louder, became indistinct and unintelligible. This was owing to another principle of electro-magnetism, which came into operation in such a case. The electric intensity of telephonic currents depends not only on motion of magnet being directly proportional to velocity of the vibrating plate, but they are inversely as square of distance. Now when the motion of the plate is very small, perhaps chiefly molecular, when moderate tones are used, the variation of distance is so small as to give no appreciable difference on this account; but when the tones are loud, the air-waves give the plate such motion that the law of inverse squares comes in, and the electric pulsation is no longer a faithful copy of the sound-wave.

All attempts, then, to increase loudness by larger battery power, varying the dimensions of the plate, or by increasing the volume of tone at the transmitting station, fail, in great degree, to reach the end sought. Many inventors have tried their skill at this problem without much success. The question then arises, is there not some other way, save by motion of a magnet, of modifying the electric current so that it shall faithfully represent sound-waves?

This leads us to the third class of electric telephones, of which Mr. Edison's inventions furnish the best examples. The genius of Menlo Park, whose fame is world-wide now, owes his reputation most of all to the phonograph, an invention suggested, doubtless, by Bell's telephone, in an attempt to improve the latter. It is not my purpose to discuss that at all, though it is not a little curious that Edison, seeking to improve on Bell's discovery,

should incidentally solve Bell's original problem, and, not only that, should also hit on a new line of telephone improvement which vastly increases the possibilities of this invention. All workers with current electricity know how important it is to secure firm metallic contacts in conductors. Here is an invention whose success depends on a loose contact. Edison's merit and success in telephones probably lies chiefly in the invention of the carbon button, which, likewise, is the foundation of the tasimeter and a dozen other novel instruments. It, therefore, merits a special description, easy to give, for it consists simply of compressed lamp-wick arising from incomplete combustion of coal oil. It is pressed, with a force of 1,000 pounds to the square inch, into the form of a little disc, one-half of an inch in diameter, and one-sixteenth of an inch thick, the breadth and thickness of an old-fashioned wafer for sealing letters. The carbon button is placed between two metallic discs, which are, in turn, joined to wires forming opposite poles of an electric circuit. The electric current, therefore, passes through the carbon. The discs which form the sides of the carbon are so arranged as to be exposed to the influence of sound-waves. These, by their condensations and rarefactions, increase or diminish the contacts of the disc with the carbon, and thus vary the flow of the electric current. This variation is found to be in such exact proportion to these small pressures that an ordinary Bell telephone reports with fidelity a message transmitted by Edison's instrument.

In applying the carbon button to the tasimeter, the heat rays are made to pass through a slit and fall upon a little bar of hard rubber. This is very sensitive to heat, and by its expansion presses on the carbon button, thus increasing the electric current, as witnessed by a delicate galvanometer. Again, the carbon button is used for a new kind of barometer, and also for a hypsometer, to measure the atmospheric moisture. Hughes' microphone employs the same principle of loose contact as the carbon button. It may have a great variety of forms, one of which consists merely of three iron nails—the two being connected directly with the poles of a battery, and the third nail being loosely laid upon these. Another way is: Make a box with tin plates passing into the interior on opposite sides, which are thus connected with the poles of a battery. The box is now filled with gas cinders, and becomes a microphone. Three or four of these hung on the walls of a room, like picture frames, were sufficient to transmit conversation going on in the room, thus realizing not only the idea that walls have ears, but mouths, too.

Time does not allow even an allusion to the many modifications that have been made in the forms of the last two classes of telephones. In spite of all that has been done, distinct articulation by telephones can be given, as yet, only in comparatively low and feeble tones, and we yet wait for Edison, or some other genius, to complete the instrument which will deliver popular harangues or concerts, and report speeches. Aside from any direct practical applications, there is a wide field of interest in the purely scientific aspect of telephones. Through them we see the inner workings of molecular forces from a new and most interesting standpoint.

We discover new evidence of the marvelous delicacy of the ear, and, conjoined with the kindred invention, the phonograph, we are possessed, for the first time, of the means for making a complete scientific analysis of speech, and may hope to make record of this fugitive aerial movement, which has hitherto been lost like the track of a vessel through the sea. Finally, the telephone teaches the wonderful potency of little things, and that many forces we count as lost go on and on, and return, perhaps, at last, to their origin, after cycles of change.

AMBLYCHILA CYLINDRIFORMIS SAY.

By Prof. Frank H. Snow, of the University of Kansas.

In considering the unintelligibility of the title of this article to one who is not a professional entomologist, I am reminded of a brief dialogue which occurred between Mr. Richard Foster, a member of my last summer's collecting party, and a cow-boy of the plains, who passed by one evening while Mr. Foster was looking for specimens. After watching him for some moments with great curiosity the cow-boy asked: "What are you doing?" Mr. Foster replied: "Hunting Amblychila." The cow-boy in great amazement inquired again: "Ambly Chila—who's she?" Who "she" is, it will be the object of this paper in some measure to explain.

In 1823 the famous entomologist, Thomas Say, discovered a single dead specimen of this insect "near the base of the Rocky Mountains." Twenty-nine years later a second specimen, also dead, was found upon the "Llanos Estacados," or Staked Plains, by one of the United States surveying expeditions. The remarkable structure and great rarity of this beetle made it "facile princeps" among American insects, and its possession was eagerly sought by our foremost entomologists. But many difficulties lay in the pathway of those who would gain the coveted prize. The regions in which the two specimens had been captured were practically inaccessible to the entomologist. No railroad had then entered the vast country lying west of the Missouri river, and hostile bands of Indians were at all times in readiness to massacre the reckless adventurers who should dare to traverse their hunting grounds without a powerful military escort. A national expedition for the survey of our immense unoccupied domains might obtain the needed protection by Government authority. But what professional "bug hunter" could hope for membership in such an expedition, much less aspire to the requisite military escort for an expedition of his own for the sole purpose of hunting an insect, however rare and however valuable in the estimation of entomologists. But, notwithstanding the inaccessibility of the plains to collectors of insects, various attempts were made to overcome this difficulty. A distinguished American entomologist, not many years after the discovery of the second specimen of Amblychila, in 1852, printed a circular containing a description and life-size figure of the beetle, which he distributed among the army surgeons at the various military posts in the Western territories. Several additional specimens were in this way obtained, and several others were brought in by some of the more recent Government expeditions. But Amblychila cylindriformis continued to be the rarest and the costliest of American insects. It could hardly be purchased for museums at any price, and not more than two years ago, no less than fifteen or twenty dollars were eagerly paid for a single specimen. Indeed, a price list of North American coleoptera issued at Cambridge only eight months ago, quotes the subject of this paper at twelve dollars per specimen.

Two causes, however, have recently conspired to bring out the fact that this insect is by no means the same rarity in nature as in entomological collections. In the first place, the withdrawal of the Indian tribes from Kansas soil to distant reservations, has made it possible for the collector of insects to visit the plains without incurring the imminent danger of losing his scalp; and in the second place, the discovery of the crepuscular and nocturnal habits of Amblychila has led to the capture of great numbers of specimens during the past season. This discovery, which had been predicted

by Dr. LeConte, of Philadelphia, was actually made in the summer of 1876 by Messrs. H. A. Brous and S. W. Williston, of the Yale College geological expedition to Western Kansas, in charge of Prof. B. F. Mudge. The members of this party obtained about 100 specimens. During the present season several hundred specimens have been collected by Messrs. Williston and Cooper, of the Yale expedition, and by the Kansas University expedition in charge of the writer. It is more than probable that the present year has been unusually favorable to the occurrence of this insect, and that the next season may prove, like that of 1876, less productive of specimens. It is a well known fact that a species may occur in great abundance for one year and then become comparatively rare or altogether unknown for several years in succession. This law will doubtless be found to apply to Amblychila cylindriformis as well as to other insects.

I was disappointed to find these insects apparently devoid of that intensely ferocious nature which had been ascribed to them by sensational writers for the Eastern press, and which would be suggested by its position at the head of a ravenous family, the Cincindelidæ, or Tiger-beetles. I have watched them night after night coming forth from their hiding-places soon after sundown and beginning their night-long search for food. I am satisfied that their sense of sight must be exceedingly deficient, as they never discover their prey from a distance, however slight, and never capture it unless stumbling upon it as if by accident. When, however, they do thus stumble upon an unfortunate caterpillar, grasshopper, or other suitable article of food, a very acute sense of touch, chiefly concentrated in their long and constantly vibrating antennæ, enables them to seize upon and firmly hold it with their powerful mandibles, while with their maxillæ or secondary jaws they withdraw the life juices and soft tissues of their struggling victim. They also manifest the imperfection of their vision by making no attempt to escape from their human captors, allowing themselves to be picked up as if entirely blind. They are slow in their movements, walking about with great deliberation over their favorite hunting grounds, the sloping clay-banks. The only approach to rapidity of movement observed during the summer was in the case of a single individual surprised by the morning sun while at a distance from a suitable hiding place which he was making frantic exertions to discover.

In a brief paper contributed to this Academy by Mr. H. A. Brous, at our last annual meeting, it was stated that Amblychilæ live in holes which they construct for themselves. My own observations do not corroborate this statement. On the other hand, I found them invariably coming forth at night from holes made by other animals, most especially from the intricately winding burrows of the kangaroo rat (Dipodomys Phillippii), by which the clay banks are often completely honeycombed. In these burrows they take refuge from the direct rays of the sun in the daytime, in company with other nocturnal genera—Eleodes, Pasimachus, etc. These latter insects undoubtedly furnish many a midday meal for Amblychilæ, which are not to be supposed to pass the entire day in sleep. On one occasion I had an opportunity of watching two of them in a large abandoned badger's hole. They were wide awake and walking about with vibrating antennæ as if in search of food. I have also kept several living specimens in confinement and have carefully watched them for several weeks, but never discovered any disposition to make excavations for themselves, though they would gladly take possession of holes made for them in the earth at the bottom of the cage.

In regard to food, no living insect seems to come amiss to them. They seem to be especially fond of all sorts of Orthopterous and Lepidopterous

larvæ. They will attack and devour the huge wingless locusts (Brachypeplus), and sword bearers (Ensicaudes). I have seen them in the act of conquering and devouring the large Prionus of the plains (P. fissicornis), and in two instances have seen them eating one another, apparently with the keenest relish. In confinement they will thrive upon full grown maple-worms (Dryocampa rubicunda var. alba), the caterpillars of the Hand-maid Moth (Datana ministra), and almost every other insect pest of the orchard and garden.

But while thus visiting the death penalty upon every member of his class with which he comes in contact, our voracious hero is himself a choice article of diet to at least one carnivorous quarduped of the plains. Mr. John M. Walker, one of the members of my party, while patrolling his accustomed beat one morning before sunrise, discovered the fresh fragments of several half-eaten Amblychilæ scattered along his route, as if some predatory animal had but just preceded him and made his breakfast upon the rarities which otherwise would have made their way into the collecting-bottle. On the evening of the same day, Mr. Walker, while collecting in the same locality, was violently attacked by a rabid skunk, twice in immediate succession. The next morning Mr. Richard Foster, the other student of the party, was similarly attacked on a neighboring clay-bank, and had the good fortune to kill his assailant. An examination of the centents of this animal's stomach revealed unmistakable remains of freshly-eaten Amblychilæ. It would thus appear that this ill-odored quadruped has an original claim to the title of "Amblychilæ-hunter," and is ready at the proper time to vindicate its claims against human contestants. This fact will merit the serious consideration of entomologists who may hereafter visit the plains, since the bite of the rabid skunk has proven fatal to man in more than nine cases out of ten, and there are more than fifty fatal cases on record. In this connection may be mentioned another danger which must be incurred by the collector of insects upon the plains. I refer to the bite of the rattlesnake, which venomous reptile abounds in Western Kansas and Eastern Colorado, and was encountered nearly every day by some member of our expedition.

NOTE ON THE HABITS OF SOME OF THE RARER CINCINDELÆ.

By S. W. Williston, New Haven, Conn.

The few following observations may be of use to collectors:

C. montana. This species I found in considerable quantities early in spring, in Southern Wyoming—more frequently along the hillsides of uplands, and not especially in bared ground.

C. pulchra. This beautiful species is extremely abundant in Southwestern Kansas and Southern Colorado. They always choose perfectly bared spots of loam, on high ground, and for that reason are oftenest seen along old unused roads. A peculiarity of their northern distribution is interesting. They are extremely abundant along the valley of the Smoky Hill river, extending nearly as far east as Ft. Hays. But during three years of active collecting in the West by Messrs. Brous, Cooper, E. W. Guild, and myself, I never learned of a specimen taken north of the divide between the Smoky Hill and Saline rivers, nor indeed beyond the immediate valley of the Smoky Hill. Another beetle with almost precisely the same limits

of distribution, is Asida elata. Amblychila cylindriformis, although occurring very rarely north of the Smoky Hill, does still reach the Solomon river.

C. scutellaris. Smoky Hill and Saline, confined mostly to sandy streams on the borders near vegetation, but nearer the open sand than formosa.

C. 10-notata. Has habits somewhat similar to montana, specially distributed in Southern Wyoming, on high grounds among the buffalo grass.

C. Auduboni. Most abundant in early spring. The black variety was most commonly seen in the open clayey bottoms of ravines and hollows near the chalk washes, and not usually intermingled with the green variety. Both varieties, or sub-varieties, were found on the Laramie plains.

C. fulgida. This beautiful species I have found abundant in Western Kansas and Southern Wyoming. They frequent the upper banks, contiguous, but at some distance from water, among the buffalo grass. Their quick flight, together with the unbared situation, render it difficult to obtain them in numbers.

C. hyperborea. Common at Como, Wyoming, near the lake's edge, with vulgaris.

C. circumpicta. This species seems to be confined to bared alkaline spots, at least it has been in such localities that I have taken them in Western Kansas and Nebraska.

A PARTIAL LIST OF THE FISHES OF THE MARAIS DES CYGNES, AT OTTAWA.

By Prof. Wm. Wheeler.

I. Perchidæ—Perches.

1. Stizostedium Americanum (Gill)—Wall-Eyed Pike.

II. Icthelidæ—Sunfishes.

2. Pomoxys hexacanthus (Agassiz)—Six-spined Bass; abundant.
3. Micropterus nigricans—Black Bass.
4. Pomotis auritus (Gun.)—Bream; plentiful.
5. Pomotis luna (Agassiz)—Moon Sunfish.

III. Sciænidæ—Drums.

6. Haploidonotus grunniens (Raf.)—Drum; abundant.

IV. Clupeidæ—Herring.

7. Dorosoma Cepedianum (Gill)—Hickory Shad; abundant.

V. Catastomidæ—Suckers.

8. Hypentelium nigricans (Jordan)—Mud Sucker.
9. Erimyzon melanops (Jordan)—Striped Sucker.
10. Moxostoma duquesnei (Jordan)—Red Horse; abundant.
11. Carpoides bison (Agassiz)—Buffalo Carp; abundant.
12. Icthyobus bubalus (Agassiz)—Brown Buffalo; abundant.
13. Bubalichthys niger (Agassiz)—Buffalo; abundant.
14. Catostomus teres (LeS.)—White Sucker.

VI. Siluridæ—Catfishes.

15. Ictalurus punctatus (Jordan)—Channel Cat; abundant.

16. Amiurus nigricans (Jordan)—Great Lake Cat.
17. Amiurus atrarius (Gill)—Horned Pout; abundant.
18. Amiurus albidus (Gill)—Western Bullhead.
19. Hopladelus olivaris (Gill)—Mud Cat; abundant.

VII. Lepidosteidæ—Gar Pikes.

20. Lepidosteus osseus (Agassiz)—Long-nosed Gar.
21. Cylindrosteus platystomus (Grd.)—Short-nosed Gar.

VIII. Petromyzontidæ—Lampreys.

22. Petromyzon argenteus (Kirtland)—Silvery Lamprey.

LIST OF KANSAS SNAKES IN THE MUSEUM OF THE KANSAS STATE UNIVERSITY.

Prepared by Annie E. Mozley, Class of 1878, State University.

COLUBRIDÆ.

Eutainia.

1. E. sirtalis B. and G. Striped Garter Snake. Douglas county.
2. E. sirtalis variety dorsalis B. and G. Douglas county.
3. E. saurita B. and G. Swift Garter or Riband Snake. Douglas county.
4. E. parietalis B. and G. Douglas county.
5. E. Marcinana B. and G. Douglas county.
6. E. proxima B. and G. Wallace county. Collected by Prof. Snow.
7. E. ———. Specimen referred to Eutainia, but disagrees with genus in having but two postorbitals, and in having very short tail. Douglas county. Very common.

Nerodia.

1. N. sipedon B. and G. Water Snake. Douglas county.
2. N. Holbrookii B. and G. (?) Holbrook's Water Snake. Douglas county.

Regina.

1. R. ———. Specimen referred to Regina, but differs from it in having more than 162 abdominal scutellæ. Probably a new species. Douglas county. Collected by F. H. Morgan.

Heterodon.

1. H. simus B. and G. Hog-nose Snake. Wallace county. Collected by Prof. Snow.
2. H. nasicus B. and G. Hog-nose Snake. Wallace county. Collected by Prof. Snow.
3. H. cognatus B. and G. Blowing Viper. Douglas county.
4. H. atmodes B. and G. Blowing Viper or Spreading Adder. Douglas county.

Pituophis.

1. P. Sayi B. and G. Bull Snake, or Western Pine Snake. Douglas county.

Scotophis.

1. S. alleghaniensis B. and G. Pilot Snake. Racer. Douglas county. Collected by W. G. Raymond.

2. S. ———. Referred to Scotophis, but does not agree in all particulars. Douglas county.

Ophibolus.

1. O. calligaster Say. Kennicott's Chain Snake. Douglas county.

2. O. getulus variety Sayi B. and G. King or Egg Snake. Douglas county. Collected by Mr. J. Savage.

3. O. eximius B. and G. House, Milk or Chicken Snake. Douglas county.

4. O. gentilis B. and G. Wallace county. Collected by Prof. Snow.

5. O. ———. Species not determined, probably new. Douglas county.

6. O. ———. Calico Snake. (Snow.) Species not determined. Agrees with O. doliatus in having the head red; with O. gentilis in having sides blotched; differs from both in having thirty-five pairs black rings. Very common. Douglas county.

Bascanion.

1. B. constrictor B. and G. Black Snake. Douglas county.

2. B. Foxii B. and G. (?). Douglas county.

3. B. flaviventris Say. Blue Racer. Very common in Douglas county.

Masticophis.

1. M. flavigularis B. and G. Coach-whip Snake. Wallace county. Collected by Prof. Snow.

Diadophis.

1. Diadophis punctatus Linn. Ring-necked Snake. Douglas county. Collected by Prof. Snow.

Celuta.

1. C. vermis. Worm Snake. Douglas county.

CROTALIDÆ.

Crotalus.

1. C. confluentus Say. Osborn City. Collected by R. B. Foster.

2. C. ——— (?). Differs from any specimen described by Baird and Girard in having but twenty-one rows of dorsal scales. The general color is light cinnamon; skin between scales, sulphur yellow. The transverse dorsal bands, twenty-five in number, are black, very short, only two or three scales longitudinally. Dorsal line, of chestnut, three scales wide. Tail black; abdomen white; sides of scutellæ mottled with black; cheeks white. Douglas county. Obtained by Prof. Snow.

Crotalophorus.

1. C. tergeminus B. and G. Prairie Rattlesnake. Massasauga. Douglas county.

Ankistrodon.

1. A. contortrix B. and G. Copperhead. Douglas county.

ON THE BITE OF THE RATTLESNAKE.

By Joseph Savage, of Lawrence.

It has fallen to my lot to narrate to you, briefly, some of the experiences of our worthy President, Prof. F. H. Snow, while suffering from the bite of a rattlesnake, which occurred during his expedition upon the plains of Western Kansas, last summer.

The party were in camp about fifteen miles south of Buffalo station, upon a small stream known as Hackberry creek. There were in the party Profs. Snow and Mudge, with students Foster and Dyche. The bite was received upon the twenty-seventh day of June, 1878. The circumstances attending it came about in the following manner:

In the morning Prof. Snow went from camp about two miles, to what is known as Cathedral Rock; this rock is a high bluff and a prominent landmark in all that region. He was here alone, until about eleven o'clock, when he returned to camp, holding a small rattlesnake in his left hand, and in his right he had a portion of the vertebral column of a fossil fish, somewhat distorted into the shape of a good sized pistol. The Professor remarked, playfully, as he reached camp, that he had a snake in one hand and a pistol to shoot it with in the other. The snake had three rattles and a button. It was decided, after some debate, to put the snake into alcohol for preservation. For this purpose a bottle with a long, small neck was produced, and after some further discussion as to methods, it was thought safest to introduce the snake into the bottle tail foremost. To this the snake objected, and in the struggle between the man and the snake, in an unguarded moment, the right hand was held above the head of the snake, when the venomous reptile, with the coils of its tail placed firmly against the neck of the bottle, darted upward with one convulsive spring taking with it the left hand and arm of its captor, and buried its poisonous fangs in the tip of the second finger of the right hand. Now, almost all men have, from habit, some ejaculation which will gush forth in times of excitement without their consent; so it was with the subject of this story, and out it came: "By George, he has bitten me." As quick as thought the reptile was thrown upon the ground and held in place by the foot, while the poor bleeding finger was instantly placed in the mouth and vigorously sucked.

Both our President and Vice-President expressed themselves pleased with having a long-cherished desire gratified of seeing the effects of a rattlesnake bite. The latter gentleman, however, expressed his willingness to have the bite on some one besides himself, while the former submitted to the inevitable without grumbling. A string was immediately tied around the bitten finger, just above the knuckle, and the bite was soon lanced, to let the blood flow more freely. The pain from the bite was very severe, the most intense of any ever before experienced, and was compared to having a hundred hot needles thrust into one's flesh, all at once. The subject of the bite had had the nerve of a tooth pulled out by a dentist, the pain of which was as nothing compared to this pain from the bite. In two or three minutes the intensity of the pain subsided into a good sound wholesome ache, which, after twenty-four hours, entirely ceased. In a few moments after the bite, the finger had swollen to nearly twice its usual size, and had turned nearly black; it was then lanced upon one side, relieving it somewhat; after another half hour it was lanced again upon the other side,

affording more relief. In about three minutes after the bite, the patient grew slightly faint, and lay down upon the ground awhile, during which period Prof. Mudge, with one of the students, continued sucking the wound.

One hour after the bite, the string was removed from the finger, after which the hand and wrist swelled up to about twice their natural size, and the arm became much discolored. The swelling had entirely subsided in forty-eight hours, but the discoloration continued for a week. The wound caused by the bite healed in two weeks, without loss of the nail. The nail, however, from some cause, showed a black spot upon it, just opposite the bite, which spot has just disappeared three months afterward. The pulse of the patient, five hours after the bite, had fallen down to fifty per minute; two hours later it had risen to fifty-six; the next morning it was beating at sixty, and in twenty-four hours it had regained its usual rate. It may be also interesting to note, that Prof. Snow responded promptly to the dinner-call, and ate so much more than usual, that the cook suggested that a few more snake bites in camp would exhaust the supply of food on hand, and an extra trip to the station for supplies would be inevitable. To the surprise of all, the Professor was out all the afternoon, collecting as eagerly as though nothing unusual had happened to him.

In regard to the number of rattlesnakes killed during a sojourn of thirty days upon the plains, only fifteen are recorded.

It should also be stated that Prof. Mudge took the snake in charge while Prof. Snow was lying down, and put it into the bottle head-foremost, without any apparent difficulty, so now our President can not only inform his classes in natural history the best method of treating a rattlesnake bite, but also inform them of the latest and most approved style of bottling them.

Another rattlesnake bite came under the special notice of the writer, in the harvest field of his brother, Mr. Forrest Savage.

It was received by one of the harvest hands, Mr. George Risley, while engaged in binding wheat during our last summer's harvest. The reaper had just passed over the snake, and Mr. Risley was binding close behind it. The bite was received on the second finger of the right hand, just above the knuckle-joint, while in the act of taking up a gavel for binding. The snake seemed to be concealed beneath the bundle, and was probably irritated somewhat by the previous passage of the reaper near its resting place, or, it may be, over a part of its body. Mr. Risley describes the bite as a blow, accompanied by a hot, burning sensation. When he withdrew his hand from underneath the grain, the snake followed with its fang still buried in his finger. A single jerk of the arm failed to release its hold, and not until a second and more vigorous motion of the arm did the reptile's fang tear its way from the cuticle of the finger; and now, six months afterwards, a large scar marks the place where the bite was given. The snake was killed—it had six rattles and a button. The alarm was immediately given to the other hands in the field, and a man was dispatched at once to the nearest house—that of Mr. Bates—for whiskey. About a pint was obtained and swallowed, as Mr. Risley expresses it, "straight."

By this time—about ten minutes after the bite—the arm had swollen to about twice its natural size, and had turned to a very dark and mottled color. The whisky reduced the swelling almost instantly, and partially restored it to its natural color. The swollen arm was then tightly bandaged, and the young man was soon carried in a buggy, the distance of two miles, to his home. Arriving home, his over-anxious friends administered about as much more whisky as was taken in the field. Then the patient became unconscious and almost unmanageable until the next morning, when he des-

cribes the pain of his scalded throat, and his burning thirst, as almost intolerable.

Dr. May was called to treat the case, which he did in the usual way of cauterizing the wound, and freely applying iodine to the affected arm. The patient kept his room for about two weeks, with loss of appetite, and general debility; after which he carried his hand in a sling, and suffered much from numbness and lack of feeling in the bitten finger. It has now entirely recovered its wonted consciousness, and Mr. Risley insists that if he ever binds wheat again is shall be done with gloves on both his hands.

ADDITIONS TO THE CATALOGUE OF KANSAS BIRDS.

By Prof. F. H. Snow, University of Kansas.

The third edition of the Catalogue of Kansas Birds contained 295 species. The following additions have since been made:

296. Neocorys Spraguei Aud. Missouri Skylark. This species was taken at Ellis, by Dr. Louis Watson, Nov., 1877. Dr. Watson states that his specimen was found solitary, but that he is satisfied that this species is "not rare in Ellis county—present every winter, and in company with Shorelarks and Longspurs."

297. Melanerpes torquatus Wilson. Lewis's Woodpecker. Also taken at Ellis by Dr. Watson, May 6th, 1878. One specimen was obtained from a flock of six or eight.

298. Nyctiardea violacea Linn. Yellow-crowned Night-Heron. Taken at Neosho Falls by Col. N. S. Goss, who killed three young birds and one adult female in breeding plumage, with eggs nearly full-formed in the ovaries.

299. Ardea eaerulescens Linn. Blue Goose. This species also was taken by Col. Goss at Neosho Falls. One bird was killed from a flock of ten or twelve.

300. Xema Sabinei Sab. Fork-tailed Gull. A single specimen, a young male, flew late at night through the open door of Peter Long's saloon, at Humboldt, Sept. 19, 1876. Reported to me by Col. N. S. Goss, who secured the specimen for his cabinet.

301. Sterna hirundo Linn. Wilson's Tern, or Common Tern. This species was in the first edition of the Birds of Kansas, but was stricken out from subsequent editions from fear that it had been confounded with Forster's Tern. It is now restored to the list by Col. N. S. Goss, who procured a specimen in Anderson county.

302. Pyrgita domestica Linn. The English Sparrow. This bird has become an abundant resident of Topeka, having been introduced by Hon. F. C. Giles in 1874. A small flock of about a dozen birds has been observed by the writer in Lawrence.

To this list may be added the following varieties of species already catalogued:

55a. Icteria virens var. longicauda Lawr. Taken along the Smoky Hill river in Western Kansas, by S. W. Williston, in May, 1877.

190a. Buteo Borealis Gen. var. calurus. Western red-tail. Taken at Ellis, Lawrence and Neosho Falls.

ON THE ADULT MALE PLUMAGE OF WILSON'S PHALAROPE.
(Steganopus Wilsoni Sab.)

By S. W. Williston, New Haven, Conn.

From careful observations the present season in Southern Wyoming, I became well satisfied that what has been hitherto considered the young plumage of this bird, has been confounded with the adult male. The birds first made their appearance in the vicinity of Lake Como, May 5th, and afterwards became somewhat abundant, breeding in the marshy lands during June. A perfectly formed egg was taken from the oviduct of a female, June 8, although search for the nests was unsuccessful. The plumage here given is based upon the uniform result of seventeen dissections, in which the female plumage was invariably as given in Dr. Coues' excellent Key to North American Birds.

Steganopus Wilsoni male. Crown dark, nearly the color of the lesser wing coverts, somewhat ashy on the occiput and nape. Forehead lighter. The stripe running from bill, back through the eyes, so characteristic of the female, is faint, and nearly the color of the forehead. The cinnamon stripe on either side of the neck, is faintly marked and speckled with ashy; breast and fore part of the neck more purely white than in the female. The interscapulars, and many of the scapulars black edged with tawny. Upper tail coverts brown, bordered with white; otherwise as in the female.

The absence of black, and the deep rich cinnamon upon the neck and scapulars, together with dark markings of the crown and back, render the plumage strikingly different from the female, and I could hardly believe, till after repeated dissections, that this soberly marked bird was the adult mate of the so richly colored female. The birds are so confiding in their habits, that after I had shot nearly a score, I forebore their further destruction, but watched them as they circled in graceful flight about me, or swam so lightly in the water. I invariably distinguished the different plumage of the pairs.

That they should have shown without exception, when at last a year old, the adult plumage in the female, and the young plumage in the male, seems wholly improbable, and I doubt not that future observation will confirm my discovery.

No words can convey the beautiful and graceful forms of these birds, as they swim so lightly about upon the water. They prefer the small marshy ponds, and never venture upon rough water. The nearly related Lobipes hyperboreus, on the other hand, delight in deep water, rising and falling upon the high waves, far beyong the reach of fire-arms.

SPERMOPHILUS RICHARDSONII.

By S. W. Williston.

I watched with considerable interest, the present season, the habits of this spermophile on the Laramie plains, where they exist in great numbers. They were seen very early in the spring, feeding upon the first green things

that appeared, and their burrows through the sand leave permanent rounded ridges of dirt. They bring forth their young early in May, gravid females being found as late as the second of the month. The first appearance of the young above ground was about the twentieth. Five was the largest number noted in one litter. The burrows do not descend far into the ground; one that was followed for ten feet was in no place more than twenty inches from the surface. They throw little or no dirt out from their burrows, choosing their entrances from little mounds, especially among the sage brush. The burrows frequently have more than one opening, but not always. In one case the young were driven out more than forty yards away from the hole in which water was poured. I caught, in this way, a dozen or more of the little fellows, taming them with but little difficulty, they readily feeding from my hands on crackers, cheese or grass. They were especially fond of milk, which they drank in large quantities. They spent most of the time in sleep, and although not very playful, were most interesting pets, scolding vehemently when annoyed. One of them finally learned the trick of raising a wire in his cage and escaping, repeating it several times, till but five were left. The last time they nibbled some poisoned bird skins, and died from the effect.

They will frequently climb high up in the sage bushes, and sit quietly feeding upon leaves or grass that they have carried. They certainly never from choice feed upon sage leaves. In the latter part of July they lose nearly all timidity in their eager search for winter's food, entering the open doors to pick up crumbs thrown from the table, and scrambling over one's feet in their restless eagerness. I have been told by several competent observers, that before the close of August they suddenly and completely disappear, not to again show themselves before the following spring.

It seems to me very probable that many of the spermophiles undergo a more or less semi-torpid hibernation during the winter months. A species common through Kansas (tridecemlineata) I have frequently tamed. The young make their appearance late in May, and within a few minutes after being caught, will be eating contentedly from one's hand. Three thus tamed were unintentionally left exposed one frosty night. The next morning I was very sorry to find my pets cold and without the least sign of life. I threw them forcibly away, and my amazement was great when, a few hours later, the cat brought one in not yet dead. Searching for the other two, I found them and replaced them in their cage, when they were soon eagerly feeding. I afterwards found them susceptible to the same torpor for many hours at a time, when exposed to the cold.

BOTANICAL ADDENDA.

By Prof. J. H. Carruth.

Since the "Centennial Catalogue of the Plants of Kansas" was prepared, nearly a year has elapsed, and I am able to add the following species. I am indebted to Mr. B. B. Smyth, of Ellinwood, Barton Co.; to Mr. James Wilson, now at Arkansas City, Cowley Co.; to Mr. Joseph Henry, of Salina; to Prof. Wherrell, of Leavenworth; to some persons unknown, but probably from the southeast corner of the State, and a few others, for plants; and to Mr. E. Hall, of Athens, Ill., and S. H. Wright, M. D., of Penn Yan, N. Y.,

for aid in determining several of them. Those I have credited to Mr. Popenoe I give on his authority. Apprehending a scarcity of space, I shall omit the orders and the common names. In two or three cases I am unable to give the authorities.

1084. Cleome pungens L. Shawnee county. Popenoe.
1085. Cleomella angustifolia Tor. Ellin.
1086. Hypericum pyramidatum Ait. Leav.
1087. Hypericum prolificum L. Law.
1088. Cerastium vulgatum L. Var. Ark. City.
1089. Petalostemon villosus Gr. Ellin.
1090. Astragalus scopulorum Porter. Ark. City.
1091. Phaseolus perennis Walt. Sal.
1092. Potentilla arguta Ph. Ark. City.
1093. Gillenia stipulacea Nutt. Southeast Kan.
1094. Ammania humilis Mx. Law.
1095. Œnothera Fremontii. Rooks county.

Mr. Popenoe found two speciments with three petals, six stamens, and pistil three-parted.

1096. Opuntia fragilis. Ellis; from Dr. Watson.
1097. Diodia teres Walt. Near Big Springs, Douglas county.
1098. Solidago nemoralis Ait. Law., Ellin.
1099. Silphium Asteriscus L. (?) Law.
1100. Xanthium spinosum L. Leav.
1101. Gaillardia aristata Ph. Sal. Popenoe.
1102. Hymenopappus scabiosæus L'Her. Ark. City.
1103. Leucanthemum vulgare Lam. Law.; from Miss Jennie Ricker.
1104. Cirsium lanceolatum Scop. Leav.
1105. Pyrrhopappus Carolinianus DC. Ellin.
1106. Vaccinium stamineum L. Possibly arboreum, Leaves only. S. E. Kansas.
1107. Dodecatheon Meadia L. S. E. Kan.
1108. Pentstemon glaucus? Grah. Ark. City.
1109. Collinsia parviflora Doug. S. E. Kan.
1110. Hedeoma pulegioides Pers. Law.
1111. Scutellaria versicolor Nutt. Leav.
1112. Lithospermum latifolium Mx. Leav.
1113. Convolvulus arvensis L. Topeka; Popenoe.
1114. Asclepias phytolaccoides Ph. Leav.
1115. Gonolobus obliquus Br. S. E. Kan.
1116. Rumex orbiculatus Gr. Ark. City.
1117. Rumex conglomeratus Murr. S. E. Kan.
1118. Rumex obtusifolius L. Leav.
1119. Rumex maritimus L. Leav.
1120. Chenopodium Botrys L. Law., Leav.
1121. Amarantus spinosus L. Leav.
1122. Stillingia sylvatica L. Ark. City.
1123. Potamogeton hybridus Mx. Law.
1124. Sagittaria lanceolata L. Sal. Law.
1125. Smilacina racemosa Desf. Leav., from Mr. C. M. Arbuthnot.
1126. Pardanthus Chinensis Ker. Leav.
1127. Zygadenus glaucus Nutt. Waubaunsee, from Mrs. S. M. Thomas.
1128. Zygadenus leimanthoides Gr. Ark. City.
1129. Juncus Balticus Dethard var. Ellin.
1130. Cyperus stenolepis Torr. Sal.
1131. Cyperus Engelmanni Steud. Law.

1132. Cyperus Lancastriensis Porter. Law.
1133. Eleocharis obtusa Schultes. Law.
1134. Scleria triglomerata Mx. Law., Leav.
1135. Carex aristata R. Br. Ellin.
1136. Carex Douglasii Boott. Ellin.
1137. Carex angustata B. strictior Dewey. Ellin.
1138. Aristida purpurascens Poir. Sal.
1139. Calamagrostis longifolia Hook. Ellin.
1140. Panicum (Paspalum ?) glabrum Gaud. Topeka; Popenoe.
1141. Panicum villosum Ell. Sal.
1142. Panicum dichotomum var. sphærocarpum Law. var. barbulatum Law.
1143. Tricuspis ambigua Ell. Topeka; Popenoe.
1144. Festuca ovina L. var. brevifolia, possibly duriuscula fls. 9. Ark. City.
1145. Eatonia Pennsylvanica D C. Law., Ark. City.
1146. Poa serotina Ehrh. Ellin.
1147. Glyceria Canadensis Trin. Law., Ellin.
1148. Equisetum lævigatum Braun. Sal.

AMERICAN JURASSIC DINOSAURS.

By S. W. Williston, New Haven, Conn.

The recent discoveries of abundant Dinosaur remains in the Rocky Mountain region, has given a renewed interest to the study of this singular order of extinct reptiles. Since the discovery, in March, 1877, of fragments of these animals in the upper Jurassic beds of Colorado and Wyoming, there have been exhumed not less than thirty tons of their remains, an amount probably exceeding all hitherto brought to light, both in Europe and America. The larger proportion of these collections are now in the museum of Yale College, and the remainder in Philadelphia, where, from their future study by the indefatigable paleontologists, Marsh and Cope, the final solution of their structure and affinities may be confidently expected.

The history of their discovery is both interesting and remarkable. For years the beds containing them had been thoroughly studied by geologists of experience, under the surveys of Hayden and King, and their position and extent carefully described and mapped out, but yet, with the possible exception of the half of a caudal vertebra, obtained by Hayden, and described by Leidy as a species of Poikelopleuron, not a single fragment had been recognized! This is all the more remarkable from the fact that in several of the localities, thus mapped out, I have observed acres, literally strewn with fragments of bone, many of them extremely characteristic, and so large and conspicuous as to have taxed the strength of a strong man to lift them! Three of the localities known to me are in the immediate vicinity, if not upon the actual town-sites, of thriving villages, and for years numerous fragments have been collected by tourists, and exhibited as specimens of petrified wood! The abundance and wide extent of their remains is almost incredible. The quantities hitherto obtained, although apparently so vast, are wholly unimportant in comparison with those yet

awaiting the researches of geologists, throughout the entire Rocky Mountain region; I doubt not that many thousands of tons will eventually be exhumed.

To an English geologist, Prof. Arthur Lakes, of Golden, Colorado, credit is due for first detecting the osseous character, and appreciating the scientific value, of these fossils. While engaged one day, in March, 1877, in company with Engineer E. L. Berthoud, of Colorado, in collecting Dakota leaves from the summit of the ridge, or "Hog-back," near Morrison, he discovered a huge caudal vertebra in bas-relief upon a slab of sandstone. Upon further investigation, a large quantity of bones were collected and shipped to Prof. Marsh, of Yale College, by whom they were described under the name of Titanosaurus montanus.

Almost contemporaneously with this discovery, the fossils were made known at Canyon City, Colorado, by Mr. O. Lucas, a school teacher, and in Southern Wyoming by Mr. Wm. Reed, an intelligent section foreman of the Union Pacific Railroad. Specimens from the former locality were sent to Prof. Cope, of Philadelphia, by whom they were named Camerasaurus supremus. Since then numerous other localities have become known in Colorado and Wyoming, and I doubt not but that future explorations will bring to light scores of outcrops rich in these vertebrate remains.

The beds consits of argillaceous shales of a grayish, or bluish gray color, variously interspersed with sandy, or sandstone strata, of from four to six hundred feet in thickness, the fossils extending through at least 300 feet in a vertical altitude. At Canyon City the deposits lie immediately upon the characteristic red sandstones of the Trias, the fossils having been detected to within seventy-five feet of the conglomerate. The beds are apparently conformable, as shown by the erosion of the valleys of two small streams, lying in a synclinal basin, the ridges of which are convergent, thus giving a transverse strike to the uneroded strata between the valleys.

Skirting the eastern flanks of the foothills, and extending for several hundred miles through Colorado and Wyoming, is a prominent ridge, or "Hog-back," of several hundred feet in height, dipping often at an angle of from 40 to 60 degrees, and usually protected above by the hard leaf-bearing sandstone of the Dakota cretaceous. Along the western slope of this ridge the fossiliferous clays or sandstones are usually concealed beneath the debris washed over them, but whenever exposed, as is often the case on the sides of valleys cutting through the Hog-back, fragments of dinosaur bones may generally be detected. Such is the case at Morrison, near Denver, where large quantities have been collected for the museum of Yale College. The fossils here extend to within at least 200 feet of the well-defined Dakota sandstone. Here, however, below the beds, the marine deposits of the Jurassic are prominent, and all, together with the red Triassic, lying conformably upon the carboniferous.

The stratigraphy is most characteristically shown at Como in Southern Wyoming. The summit of an anticlinal ridge has here been excavated, and a basin formed for an alkaline lake. A steeply inclined ridge of several miles in length is prominent immediately south of the lake with the fossilliferous strata largely exposed. The fossil outcrops here extend from near the summit of harder sandstone, which has not yet produced any cretaceous fossil leaves, down to near the marine beds containing an abundance of characteristic Jurassic invertebrates. The bluish clayey shales here preponderate, but are variously interspersed with admixtures of clay and sand, soft and hard sandstones, in all of which fossils are found, in some cases even large bones being imbedded, partly in sandstone, partly in shale. Invertebrate fossils are extremely rare. Of the vertebrates the individuals most

numerously represented are the tortoises, (Compsemys) with not infrequent teeth of Ceratodus, and vertebræ probably of the same. Of isolated teeth, those most frequently met with pertain to the crocodiles and carnivorous dinosaurs. Isolated bones of single individuals of the larger species are occasionally found, but not in a single instance do I know of numerous bones, pertaining to one skeleton of such species, being found unmixed with other remains. By far the most commonly, extensive deposits, or "quarries," are found containing remains of numerous individuals mingled together in the most inextricable confusion, and in every conceivable position, with connected limb bones standing nearly upright, connected vertebræ describing vertical curves, etc., precisely as though in some ancient mud holes these huge monsters had become mired and died, and succeeding generations had trodden their bones down, and then left their own to mingle with them. Such extreme confusion is however only seen in the clay deposits containing fewer waterworn fragments and small animals.

In sandstone deposits the large bones, though variously intermingled, are generally lying more nearly horizontal, with abundant waterworn fragments, and numerous remains of turtles, crocodiles, fishes, and small saurians.

These beds have hitherto been classified as the lower or Dakota group of the cretaceous, and still are by Prof. Cope. That no marked line will be found separating these estuary deposits from the Dakota, as defined by the distinguished paleontologist, Prof. Lesquereux, is possible, but until better evidence is obtained among the invertebrates to unite them, it will be far more reasonable to accept the evidence of the vertebrates, and assign to them, as Prof. Marsh has done, an equivalency with the European Wealden or Upper Jurassic.

So far, in addition to the dinosaurs, one species each, of fish, tortoise, crocodile, (Diplosaurus Msh.) pterodactyl, (P. montanus Msh.) and mammal (Dryolestes priscus Msh.) have been described from this formation. Of the dinosauria, so far thirteen genera have been characterized by Profs. Marsh and Cope, as follows: Titanosaurus Msh, (Atlantaurus Msh), Stegosaurus, Msh, Nanosaurus Msh, Camerosaurus Cope; Apatosaurus, Msh, Allosaurus Msh, Caulodon Cope, Trichosteus Cope, Amphicoelias Cope, Mososaurus Msh, Creosaurus Msh, Laosaurus Msh, and Diplodocus, Msh, and of which probably one-half are synonyms. Titanosaurus and Camerasaurus are without much doubt synonymous, and the latter is considered by Prof. Owen identical with his Chonlrosteosaurus, which is, however, only known from two imperfect vertebræ from the English Wealden. The same evidence would however include Apatosaurus and Mososaurus, but among these there are certainly two valid genera, as proved by the structure of the pelvic girdle, and hence, till the original type of Chondrosteosaurus is better known, it will be premature to unite the American species with it. According to the rules of Zoological nomenclature, no genus is entitled to acceptance, unless it is distinctively characterized. But so long as it is the custom to define genera from single bones, or uncharacteristic parts of the skeleton, such a rule has its objections. If, as in the present case, several genera, which can not be individually separated from the original imperfect type, are successively eliminated, the last must assume the type name; but this original genus may be found, when better known, to be distinct from any of them, or perhaps identical with some other one previously eliminated. Or, perhaps imperfect specimens may be found that can not be generically separated from others in remote formations, and where to unite them would be doing violence to our preconceived opinions of the persistence of geological types. But, on the other hand, the indiscriminate application of names

to genera, that can neither be positively united with, or separated from, previous ones, is pernicious.

The group of saurians represented by these four or five genera, including also Amphicoelias and Diplodocus, together with Ceteosaurus, Owen and other European ones, have been characterized by Marsh under the name Sauropoda, which, together with Huxley's Ornithoscelida, or true dinosaurs, have been made suborders of Dinosauria. They are intermediate between the crocodilia and true dinosaurs. They were the largest of terrestial animals, herbivorous, probably amphibious, and awkward and slow in their movements. The head, and especially the brain, was very small, the neck long, the dorsal vertebræ massive in their proportions, but cavernous and pneumatic, so interlocked as to give great strength and but little beuding. The sacrum of several vertebræ, solidly united, and the tail heavy and long. They walk upright upon all four nearly equal massive legs; the feet with five short toes. The largest of these described by Prof. Marsh could not have been less than eighty feet in length and twenty feet in height, and, probably, thirty tons or more in weight. Although of such almost incredibly gigantic proportions, they were doubtlessly inoffensive and harmless in their nature, relying neither upon agility or defensive weapons for protection, but rather upon size alone.

Stegosaurus was described by Marsh as a separate order, but it is possibly allied to the Sauroscelida. It was a large reptile with a heavy dermal osseous plates or exoskeleton.

The Ornithoscelida are represented by Nanosaurus, Laosaurus, Allosaurus, Creosaurus, and a species referred to the Cretaceous genus Drytosaurus (Laelaps) by Cope, and indicate three well marked families.

Nanosaurus was the smallest, and together with Compsognathus, from the European Wealden, to which it is probably allied, the most ornithic of known reptiles. They were animals scarcely larger than a cat, with short thighs, and long, slender legs, the limb bones being extremely hollow and pneumatic, as in most birds. They doubtlessly walked erect upon the two hind limbs, with very short and weak fore limbs, and were quick and agile in all their habits.

Laosaurus was a genus of dinosaurus very closely allied, perhaps identical, with Iguanodon and Hypsilophodon of the European Jurassic. They were herbivorous animals, which, in the largest known species, measured perhaps ten feet in length, or, when standing erect upon their hind legs, which they must have habitually used, were about five feet high. The head was of moderate size and the teeth serrated upon the edges; the neck was short, not at all slender; the shoulders small, and the fore legs not more than half as long as the hind ones. The pelvis showed a singular mingling of the bird and reptile types. The pubes and ischia, if united in symphyses at the ends very feebly so, and probably not at all. The pubes had two rami or branches, the anterior one, the homologue of the lizard or crocodile pubis, a slender spatulate bone, with free ends; the posterior branch or bird pubis, long, slender rod-like bones, extending back parallel to the ischia, in a manner particularly like the struthious birds. The thigh and leg bones were of nearly equal length, rather slender and hollow; the tarsus very similar to that in the bird, the foot slender and three-toed. The tail was probably rather long and compressed from side to side. Other species were smaller, of less than half the size of the larger ones. They were less bird-like than the preceding, but more so than the following.

Allosaurus and Creosaurus, which are possibly synonymous, together with Dryptosaurus trihedridon, comprising probably not more than two or three species, without much doubt included, together with Megalosaurus

and Poikelopleuron of the European Wealden, to which they are strongly allied, the most carnivorous and rapacious of terrestrial reptiles known. The teeth are long and sabre-like, recurved and minutely serrated, and the jaws were doubtless furnished with strong masseter muscles. The fore limbs were, in all, much smaller than the hinder; the neck was short, the tail probably slender, and very effective as a weapon. The pelvis is very imperfectly known in all the carnivorous genera, but was undoubtedly very narrow, as shown by the sacrum. The astragalus was very bird-like, with a high ascending process; the feet three-toed. The claws were extremely slender, curved, and pointed. The bones were all very hollow, light, and of dense osseous texture. Creosaurus is estimated at thirty feet in length. They probably habitually walked upon the hind feet, progressing rather by leaping than by strides.

Caulodon and Tichosteus are very imperfectly known from teeth and fragmentary vertebræ.

That not only in species, but also in individuals, this age was very prolific, seems probable from their abundant widely scattered remains, and moreover, localities but a few hundred miles apart, seem to differ much in their species. Not a single species has been found identical in any of the three localities mentioned above, although there possibly may be upon further study. Upon many obscure problems of the ancient Mezozoic life, much light may be confidently expected from the vast unexplored deposits of the Rocky Mountain Jura.

CRETACEOUS FORESTS AND THEIR MIGRATIONS.

By Prof. B. F. Mudge, Manhattan.

One of the most interesting problems of geology, is the study of the geographical distribution of animal and vegetable life over the globe, in the different geological ages, and more particularly the migrations from one portion of the earth to another, consequent on the sinking of one area beneath the ocean, and the rise of another. Such changes of land have been exceedingly slow, and consequently the migrations of animal and vegetable life have been equally so.

Prof. Asa Gray has recently, in the American Journal of Science, given us a very interesting essay on the origin by migration of our forests of America and Europe. He describes the close relationship of the living forests, and those fossilized in Greenland in the Miocene deposits. From a series of facts, he comes to the conclusion that the flora of both continents have descended from the common stock which lived in Greenland during the Miocene epoch. He stops there and goes no further back. He does not inquire from whence came the Greenland forests.

Now by the labors of Herr and others, we have a knowledge in detail of the Greenland flora, not only in the Miocene, but in the Upper Cretaceous. They show a near resemblance to the vegetable life of our Dakota group. As the latter is much older than the former, we now propose to give our reasons for believing that the Dakota epoch of Kansas, Nebraska, and some portions of the Rocky Mountain region, was the true and original nativity of the latter forests now fossilized in the deposits of Greenland.

To do this, the facts will be a little clearer if we show, by the labors

of Prof. Lesquereux, the close resemblance of the Dakota forests, and those now living in the temperate portion of the United States. In his "Cretaceous Flora," and other publications, Prof. Lesquereux has given us a careful description of 164 species mostly of forest trees. Of these about three-fourths are dicotyledons, or representatives of our forest and fruit trees of the temperate zone, excepting the evergreens. They are distributed among nineteen orders and fifty-two genera. They embrace the Oak, Willow, Poplar, Magnolia, Sassafras, Buttonwood, Tulip tree, and also Pyrus and Prunus, to which our best fruit trees belong; and in addition a few semi-tropical forms, like the Fig, which now grows wild in Florida. Of Prof. Lesquereux's list of fossil plants from the Dakota, fifty-six per cent. of the genera are identical with those now living east of the Rocky Mountains, in the temperate zone of the United States. To this must be added twenty-four per cent. which are apparently identical, represented by Populites, Betulites, Acerites, Negundoides, Laurophyllum, etc. Of the remaining twenty per cent., a few, like the Fig and Cinnamon, are now living in the tropics, while a few genera have become extinct.

When we examine the species under these genera, we find some exactly identical with those now living, and many others apparently so. Sassafras officinale, now the only species growing in the United States, was first discovered in the Dakota, by the writer, and named by Prof. Lesquereux, S. Mudgii, but on careful examination by him and Prof. O. Herr, the identity of the Dakota and living species is well settled. This species, and apparently other species, have been found in Greenland, and one closely allied to it in Europe. Fagus polyclada, of our Dakota, "is an exact representative of the only species of beach in America." Persea Sternbergii from the same deposits compares closely with P. gratissima of Cuba and Brazil. Others, like Cinnamomum Scheuchzeri, though not coming down to the present time, hold their specific characters, from the early Cretaceous of America to the Miocene of Europe.

The Conifers show even a stronger persistence in retaining their characteristics. Saporta and Marion, in their Flora of Gelinden, speaking of Pinus Quenstedti, which is found in our Dakota and in the Upper Cretaceous of Greenland, say, "This species does not differ in character from the living Mexican species with quinate leaves." Sequoia gigantea, our big redwood of California, is recognized as the S. Sternbergii of the Miocene, found at Disco. So Sequoia fastigata is the deposits of Kansas Miocene and the Greenland upper Cretaceous, is considered by Lesquereux very nearly the same as S. condita, fossil, and the living S. gigantea and S. sempervirens.

Prof. Gray expresses his idea of the close resemblance in the following terms: The twigs of the Sequoia in the Eocene, are "so very like S. gigantea of the Sierra Nevada, that if such fossil twigs, with leaves and cones, had been dug up in California, instead of Europe, it would confidently be affirmed that we had resurrected the veritable ancestors of our giant trees."

The Bald Cypress, now our only living species, has a close ally in the fossil Glyptrostrobus; "a sort of modified Taxodium, about as much alike as one species of redwood is like another."

As the Conifers are a very old family, coming down from the close of the Silurian Age, this resemblance and persistence of features does not impress us strongly. But it must be borne in mind, that neither Sequoia nor Taxodium have been found in any part of the globe in formations older than our Cretaceous.

The flora of the Dakota is more nearly allied to our living trees than to the forests of Europe. That quarter of the globe has no Magnolia, Liriodendron, Liquidamaer, Sassafras, Coffee tree (Gymnocladus) or Wal-

nut, yet all are found living with us, as well as largely represented in our Dakota fossils. Europe has no Catalpa, but we have the fossil Protophyllum, which appears to be nearly the same.

It is also a fact of much interest to note that the proportion of apetalous and polypetalous plants, of imperfect and perfect flowers, in Prof. Lesquereux's list, is very nearly the same in the Dakota group as in our living flora.

According to our present geological knowledge, the American lower cretaceous contains the first and oldest Dicotyledons. Future discoveries may give us a still further antiquity to our forests. But as the early Cretaceous flora has been known for many years, and carefully studied without finding anything of the same type in any of the older formations, it is very probable that we must date the origin of the Dicotyledonous plants with the dawn of the Cretaceous age.

At the close of the Dakota epoch we know that a long period elapsed, extending to the close of the Cretaceous, during which all portions of the United States from the Atlantic to the Pacific, excepting a few islands, and probably the southern part of British America, was under the ocean. It was the reign of the large fishes, saurians, etc., found fossilized in Western Kansas, Nebraska and Wyoming. During this time the forests became locally extinct. But their representatives are found in the northern regions in the Upper Cretaceous, over extensive areas, that betoken a continent, or at least continental islands. The leaves and other remains of the forests occur in Alaska, near Mackenzie river, North Somerset and Greenland; and undoubtedly at intermediate points.

These facts, and the strong resemblance between the floras of the Dakota period and those of Alaska, Mackenzie and Greenland, together with their common alliance to our living forests, justify us in concluding that the vegetation of our lowest Cretaceous slowly migrated; and, the climate in the northern regions then being like that of Virginia and the Carolinas at the present day, it overspread a large extent of the northern regions, far within the Arctic Circle. When in the Tertiary times, the sunken continent arose again, the flora, returned to its former home. As the Rocky mountains arose in the Eocene it came back by the way of that backbone of the continent, and thence spread over the whole of the temperate zone of North America. Those with a preference for mild winters inclined to the western slopes, and others took their way toward the East, as Prof. Gray has narrated. Many small shrubs, protected by the large trees, went and came with them.

When we consider the long periods covered by the Cretaceous and Tertiary ages, the rate of migration may have been exceedingly slow. If we allow a century for a life generation of each forest, the seed of the trees need not have been carried more than a single mile in a single generation. Thus slow but sure is the plan of nature's operations.

INTERNAL HEAT OF THE EARTH.

By Prof. B. F. Mudge.

We frequently notice, in newspapers and popular treatises on geology, the theory stated, in the most deliberate manner, as if it were accepted by all scientific men, that heat rapidly and regularly increases from the sur-

face to the center of the earth. They tell us that at the depth of twenty or thirty miles, and from thence to the center, the whole mass of the globe is in a fluid, molten state, having an intensity of heat which even the imagination of the chemist can hardly comprehend. This theory is based on the hypothesis that, starting from the surface, there is a constant and uniform increase of heat, at the rate of one degree F. for every forty-five feet in depth. This would give a temperature of 212°, or that of boiling water, at little more than a mile. As iron melts at 3,000°, that temperature would be reached at twenty-five miles. At a depth of about fifty miles a heat would be found, sufficient to melt the most infusible rocks. Most of our strata, like limestone, would yield at a less heat. At the center of the earth, by the popular ratio, it would be 600,000°, or eighty-five times greater than that required to melt any combination of natural elements (except platinum) found in the earth's crust. Some observations make an increase of heat equal to one degree for every thirty-two feet. This would place the molten ocean nearer the surface of the earth, the crust thinner, and the heat at the center more intense.

This theory was advanced by some of the early writers, on a limited array of facts, and a narrow comprehension of nature's laws. We know of no geologist of high standing at the present day who sustains this theory.

The first and great objection to this hypothesis lies in its opposition to well-known chemical laws. Every chemist who fuses metals in the laboratory, and every furnace-man in our iron, zinc or copper foundries, knows that when he has raised his crucible, or furnace, to the melting point of any metal, he can by adding fuel raise the molten material to far higher degrees of heat, but if he throws in pieces of the unmelted metal the temperature will not rise beyond the melting point, till the last ounce has become liquid. Thus, lead will melt at 625°, but after melting, its temperature can be raised hundreds of degrees till it boils, or even becomes vapor. But if when the lead has just reached the melting point, bars of lead, or even shot, are added to the liquid surface of the furnace, the temperature will be constant at 625°. This rule applies to all known substances. It is often seen in the familiar example of water. So long as a fragment of ice remains in our kettles, no fire will raise the temperature of that fluid above 32°. Apply this simple chemical test, and it at once settles this question, that the interior of the earth, if liquid, can not be above the melting point (7,000°) of the most refractory portions of the earth's crust. If the heat of the interior exceeded that point, this thin crust, whether of twenty-five or one hundred miles, would be immediately melted into the common mass, and we should not be here today to discuss its plausibility.

Still, it remains to consider how far we have any data to fix the rate of increase of heat, and at what depth the crust of the earth may be in a melted state. Let us look at the facts on which the theory of a regular and uniform increase of heat downward, is based.

Prof. Wm. B. Rogers, on examination of the coal mines of Eastern Virginia, computed the increase at one degree for every sixty feet. In the United Copper Mines of Cornwall, 1,201 feet deep, the increase is about half as much, or thirty-one feet to a degree of heat. At the coal mine at Ravin, France, 597 feet deep, the increase is one degree for every fifty-five feet. At another coal mine in the same country, at Castellan, 630 feet deep, one degree to forty-one feet. At another at Littry, 325 feet in depth, one degree for thirty-six feet. At a coal mine at Wigan, Lancashire, England, 750 feet deep, one degree for each forty-eight feet, but far from a uniform rate of increase at various depths. At the coal mine near Sunderland,

England, 1,584 feet deep (going 1,500 feet deper than the sea level), the increase is one degree in sixty feet. At the Dolcoath mine, Cornwall, 1,381 feet deep, one degree for every fifty-four feet. But the mine at Bechertgluck, Saxony, calls for particular attention. The whole depth is 1,246 feet. For the first 236 feet from the surface the increase of heat is at the rate of one degree for every 175 feet. For the next 316 feet, one degree for each sixty-four feet. For the next forty feet, about one-third of a degree. Then for 289 feet, one degree for each sixty-seven feet, and for the remaining 366 feet, one degree for sixty-five feet. Thus we have five different rates of increase in one mine, the extremes being one degree for 175 feet, and sixty-four feet, or a variance of 275 per cent. This shows that in this mine—a very deep one—there is no systematic rule for the increase of heat with the depth. It will be noticed, also, that the extremes of variation are included in a depth of 552 feet. As this is a variation caused by local influences, may not the heat in other mines be also owing, in a greater or less degree, to local causes? The lead and silver mine of Kurpinz, in the same country, shows a similar example of variation. The mine is 1,063 feet deep. For the first 413 feet the increase is one degree for each thirty-one feet. For the next 273 feet it is at the rate of one degree for each forty-three feet; and from thence to the bottom of the mine, 377 feet, at the rate of one degree for fifty feet. Here is a variance of sixty-one per cent. An increasing ratio, but not a uniform one. In the immediate vicinity is another mine, Junghoke, where the increase is one degree to 102 feet.

Springs in mines, and more particularly artesian borings, which have been carried to great depths, have been quoted to show the same law of increase. The results of the observations are far more variable.

In a spring in the mine of Kurpinz, 634 feet deep, the increase is one degree for each nineteen feet. At Westphalia, in a well 2,200 feet deep, the increase is one degree for fifty feet. At Yakutz, Siberia, in a well 407 feet deep, Magnus found a gain of one degree for each twenty-seven feet. Other places in Siberia show that the increase varies from thirty to as low as fourteen feet to each degree.

The springs in the lead mines at Paullanen, Britany, show an increase varying from eighty-two feet to 351 feet, to one degree of heat.

At an artesian well near Berlin, 675 feet deep, there are three degrees of ratios of increase, being one degree for twenty-eight, thirty-five and thirty-six feet, respectively. In America the artesian wells are equally at variance with any settled law of increase. At New Brunswick, N. J., at a well 394 feet deep, there is an increase of a degree for every seventy-two feet. At Charleston, S. C., 910 feet in depth, a well gives one degree to each sixty-four feet. At Connelsville, Ohio, 400 feet deep, a boring gave one degree to 120 feet. Another at the same town, 819 feet deep, gave no increase. A well also, near Chicago, about 1,200 feet, showed "no appreciable increase of heat."

The Artesian well in the State House yard, at Columbus, Ohio, 2,575 feet deep, gave a degree for every seventy-one feet. At Louisville, Ky., a well 2,086 feet deep gave a degree to seventy-four feet. The well at St. Louis, Mo., the deepest in America, 3,843 feet, is the most remarkable. At 3,029 feet it showed a nearly uniform increase of fifty-seven feet to a degree, but for the remaining 814 feet it decreased two degrees, or a loss of a degree for each 407 feet.

If this rule of a regular increase of heat were a reliable one, we might expect that the waters of the ocean would show a large increase of heat as

we penetrate its depths. But no such result has been discovered. On the contrary, all our deep sea soundings show a state of temperature adverse to this theory. According to nearly all the facts in our possession, instead of a theoretical rate of increase, there is a steady and somewhat uniform decrease, so that the bottoms of the great oceans are near the freezing point of fresh water. The soundings on the Telegraph Plateau, in the North Atlantic, sustain this, as the water was usually, at the bottom, below 40°. Off the coast of Norway, lat. 76° 17′, long. 13° 53′ E., the temperature at the bottom, 9,000 feet deep, was 32° and 33°, while the surface was 41°. The numerous soundings, both in the Atlantic and Indian oceans, by the Challenger, show that all the deep portions of these oceans were of a uniform cold temperature, much below that of the surface. But the rocks underlying the great oceans, twenty and thirty thousand feet, are so much nearer the hot regions of the earth, that they should, if the popular theory is true, be far above the average temperature of the surface, if not to a high, almost boiling degree.

That the interior of the earth has a higher temperature than the surface appears to be certain, but that a moderately high percentage of it is in a molten state is not sustained by science. The examples we have given, and many more of a similar character might be added, show that there is no regular rule which will give us even an approximate knowledge of the heat of the center of our globe.

Some very valuable scientific investigations were made many years ago, by Prof. Hopkins, of London, in relation to this question. His conclusion was, that the crust of the earth was not less than eight hundred miles in thickness, and that the fluid portions of the interior, were little, if any, above the melting point of refractory rocks.

Sir Charles Lyell, in Principles of Geology, says of the theory of the intense increase of heat toward the interior of the earth, "It seems wholly inconsistent with the laws which regulate the circulation of heat through fluid bodies." The fluid portions under volcanos must, therefore, be regarded as exceptional and local.

Prof. J Le Conte, in his recent work, says we must base our geology on substantially a solid globe. Prof. J. D. Dana, in his last edition of the Elements of Geology, makes about the same conclusion.

KANSAS MOUNDS.

By F. G. Adams, Topeka.

The first recorded mention of ancient mounds in Kansas, was made of mounds near Fort Leavenworth, by Rev. Isaac McCoy, in his account of the survey made by him, of the boundary lines of the Delaware Indian reservation in 1830. This Mr. McCoy was one of the first to bring forward the project of transferring to Kansas, from the East, the Indians of the various emigrant tribes which the settlers of Kansas found here twenty-three years ago, occupying large portions of what is now the most populous part of this State, but who have since that time nearly all been removed to the present

Indian Territory. Mr. McCoy was a missionary on the Wabash and St. Joseph rivers, in Indiana and Michigan, as early as the year 1817. Experience had taught him that contact with frontier white men, gathering in around his missionary stations, resulted in undoing the work of education and civilization which he and his associations had for a time accomplished with the Indians. He became impressed with the opinion that their removal to a remote territory would enable the missionary work to have the full effect of Christianizing and civilizing the Indians. He personally presented his views to Secretary John C Calhoun, and to Presidents Monroe and John Quincy Adams, all of whom approved the scheme, and commended it to the action of Congress. After its adoption, Mr. McCoy was made the agent of the Government, in the assignment of reservations to the several tribes. In the performance of all that work; first of securing the adoption of his scheme of the policy of the Government, and then of personally effecting the removal and establishing his missionary stations among the Indians, Mr. McCoy displayed the character of a true Christian hero, the like of whom, it seems to me, we have scarcely had upon Kansas soil since his time. The simple narrative of his labors, and of those of his co-laborers, David Lykins, Jotham Meeker, and Robert Simmerwell, as contained in the volume entitled "The History of Baptist Indian Missions," published in 1840, presents examples of wonderful Christian zeal. Considering that the work done by these men related to efforts for the civilization of people of the American aboriginal race, and that the work pertained to Kansas, an appropriate subject of investigation is here suggested in the anthropological department of this Academy.

Mr. McCoy made the survey of the Delaware reservation, in the months of October and November, 1830. The flag-staff at Fort Leavenworth was made the initial point of the northern boundary line. The Fort was then merely a military cantonment which had been established five years before. The line was made to take a direction west by north for a distance, so as to give the Delawares an outlet to the buffalo plains, shunning the then Kaw reservation, afterwards the Pottawatomie reservation. Thence the line was extended due westward, till it reached a distance of 200 miles from the Missouri river. During the prosecution of this survey Mr. McCoy's party encountered two of those sand and charcoal storms, not uncommon in the early days of Kansas, but now never occurring in the older portions of the State, in which the air became so filled with dust and the remains of recently burnt prairie grass that almost the darkness of night came on at midday. He saw and described the Great Spirit Spring, and tells us that the name Wa-kon-da is a term of the Kansas Indian tribe, meaning Great Spirit Spring. He examined the salines of the Solomon and Saline river country, and otherwise made his survey one of much value in a scientific point of view.

This historical explanation has been made because the facts mentioned have a scientific bearing; and they may not be known to all, as the book in which they have been found has long been out of print.

In respect to the Fort Leavenworth mounds, Mr. McCoy says:

"The ancient artificial mounds and fortifications, so common in the Western States, are seen less frequently as we go west from the Mississippi river, and they disappear in the prairie country original to the Indians. About a mile west of Fort Leavenworth, on a hill which commands a fine prospect in every direction, we discovered eight mounds near to each other, which from their relative position and their structure, attracted our particular attention. They were about twenty-five feet in diameter at base,

six of them nearly in a direct line, about thirty feet asunder, and the other two were on each side of the line opposite to each other near the center. They were composed of stones and earth; the former placed in a circle. One of these mounds we excavated, and in the hollow within the circle of stones we found a few human bones, some of which had belonged to adults, and others to children. Excepting the pieces of the skulls, they were so much decayed that, with the assistance of Dr. Rice McCoy, and Dr. Bryant, surgeon of Fort Leavenworth, it was not easy to discover to what part of the human body they belonged. They had been under the action of fire, and were mixed with charcoal, burnt earth, and stones that had been heated with fire. It appeared that after the bodies had been subjected to the action of fire, without being consumed entirely, they were covered with earth.

"Some Indians on the Columbia river burn their dead; but whether they leave any portion of the bones in the place of burning, I have not been informed. The place where these mounds were erected, and their internal appearance, favored the conjecture that human sacrifices had there been offered."

As regards the recent examinations of the mounds, they have been only partial, but have been sufficiently prosecuted to demonstrate the correctness of Mr. McCoy's observations, and to warrant the belief that the mounds belong to the works of the true mound builders of North America.

In June last, in company with Mr. Henry Kuhn, of Leavenworth City, I visited the location. We drove from the Fort, up to, and along the beautiful road-way, known as the "Sheridan Drive," which passes along on the top of that extension of the Pilot Knob ridge which circles along the west line of the Military Reservation, about one mile westward of the Fort. We found six mounds near this road, one on the west side of the road and five on the east side. At a more recent visit, made in company with Dr. R. J. Brown, of this Academy, Dr. B. E. Fryer, of Fort Leavenworth, Mr. R. N. Hershfield, and others, a seventh mound was seen; perhaps a quarter of a mile remote from the first six mentioned. The latter are in an irregular line, generally about forty feet apart. They are about twenty-five feet across at the base, and are quite flattened, none being more than four or five feet in height. These mounds as seen do not exactly correspond in number and position with those described by Mr. McCoy, and other observations will be necessary in order to identify the particular mounds.

At the visit in June, an excavation was made into one of the mounds. The excavation was commenced at about the center of the top, and an oblong opening made towards the circumference, about two and one-half feet in width, and four and one-half feet in length, and extending to the bottom, about four feet. Stones projected from the top of the mound, and stones of all sizes were closely intermingled with earth to the depth of about two feet, causing much labor with pick to proceed to that depth with the digging. After that, soft earth, easily thrown out with the spade, was found, to near the bottom, when some more stones were found. These had marks of fire, as did also the earth in some places near the bottom. Fragments of bones were found intermingled with the stones and earth near the bottom. The fragments are here exhibited. Some of them appear to be somewhat charred. Some pieces of skull are evidently human remains. The others may be. But here is a fragment of deer horn, apparently partially charred. One tooth thrown from this mound, now in the possession of Dr. Fryer, was identified by him as a human tooth.

At the more recent visit spoken of, another of the mounds was opened

in part. This mound exhibited at the top an elliptical boundary line of projecting points of stones; the ellipse measuring twelve feet by nine feet in its axis. No stones appeared at the surface, except in the curved bounds of this ellipse. The excavation was made through one end of this ellipse, and an irregularly laid stone wall was found extending from the top of the mound to the bottom at this place. The partial excavation made indicated that such a wall followed the elliptical line of projecting stones around the mound, inclosing a mass of earth within. Near the bottom at the place opened was found, extending inward from the wall towards the center of the mound, a vault-like opening. This, however, may have resulted accidentally by reason of the immethodical manner in which the wall was laid up. No human remains or other relics were found in making this imperfect examination of this mound.

It was hoped that opportunity would admit of a more thorough examination of the Fort Leavenworth mounds. Yet, while what has been done affords materials for but little additional to the contributions of scientific knowledge brought in at the meetings of this Academy, what is here presented may prove of service, as leading to investigations yet to be made in the direction of determining to what extent the works of the mound builders exist in Kansas. These mounds are, it is believed, the only ones yet seen in Kansas, of which any record has been made.

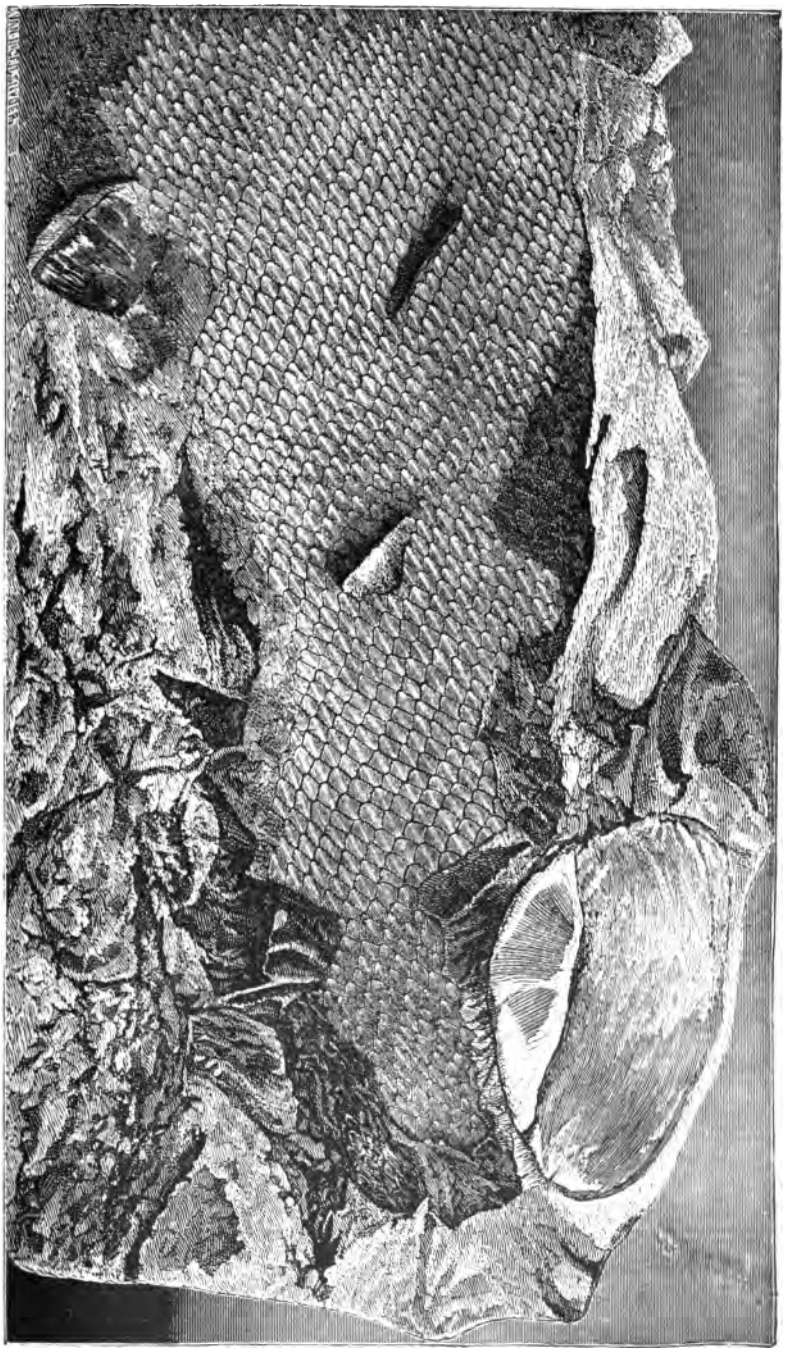
ON THE DERMAL COVERING OF A MOSASAUROID REPTILE.

(Liodon dyspelor Cope.)

By Prof. F. H. Snow, of the University of Kansas.

The geological section of the Kansas University scientific expedition for 1878, in charge of Prof. B. F. Mudge and the writer, examined with care a portion of the blue-gray shales and the yellow limestones along the Hackberry creek, in Gove county, Kansas. These rocks belong to the Niobrara group of the cretaceous formation. The locality had been previously visited by several parties of geological explorers, who had obtained from it many valuable fossils, and it was hardly expected that the gleanings from a field so thoroughly worked would contain anything of unusual value. But the frosts and rains of a single year had exposed to view many remains of fishes and saurians, and our labors were unexpectedly and abundantly rewarded. In less than three weeks, 41 saurians, 117 fishes, and 6 pterodactyls (Pteranodons) were discovered, many of them in almost perfect condition, and all of them of sufficient value to justify their transportation for a distance of 300 miles, to take their places in the cabinets of the University.

The most valuable specimen was a saurian, found in the yellow limestone, by the writer. A single vertebral bone was first observed, on June 17th, upon the blue shale at the bottom of a narrow ravine. No further remains were discovered until the following day, when a systematic search was made, in company with my assistant, Mr. L. L. Dyche. We soon detected a second bone, this time one of the phalanges, lying loosely upon the side of the ravine, several feet above the first bone, and a little farther up the ravine. In a few moments more the head of a vertebra was obscurely seen in the face of the solid limestone, about eight feet from the top of



Photographed by A. G. Da Lee, Lawrence, Kansas. Drawing made by Edw. J. Nolan, Philadelphia.

DERMAL SCALES OF *LIODON* OWEN (*TYLOSAURUS* MSH.) (Natural Size.)

the ravine. An hour's work served to detach a block of rock containing several vertebræ and other bones. While removing the superfluous material from this block, in order to facilitate its removal to camp, a fortunate stroke of the hatchet revealed a peculiar reticulated surface, several square inches in extent. The thought instantly flashed upon my mind that here was something which had never before been seen by human eye. The conclusion was irresistible that the reticulated surface was the fossilized covering of the skin of the saurian, so perfectly preserved that every scale was distinctly visible, its outline clearly marked, and the elevated central line, or "carina," unmistakably indicated. Although, according to Prof. Dana's time-ratios, a period of five million years must have elapsed since this saurian swam in the shallow waters of the cretaceous seas of Western Kansas, yet each individual scale exposed to view was as perfectly preserved as if the animal had but yesterday died.

Prof. Marsh, of Yale College, some years ago described the large dermal plates, or scutes, belonging to other mosasauroid genera, which, as he writes me, "appear to be mainly confined to the neck and throat." But, so far as I am able to learn, nothing has been hitherto known of the general covering of the saurian body in any genus, and nothing whatever of the dermal covering in the genus Liodon. It might have been expected that this covering would be found to consist of larger plates, like those of the alligator and crocodile. On the contrary, it is composed of small scales, much resembling in size, shape and arrangement, the scales of living Ophidians. Dana, in his Manual of Geology (2d Edition, p. 465), speaks of the mosasaurs as "snake-like reptiles." This comparison is strengthened when it is found that their dermal scales were almost an exact pre-figuration of those of the rattlesnake, which infest the ledges within which these saurians are found. The scales first exposed to view appeared to be on the anterior portion of the ventral surface of the body, but another small area was found not far from the pelvic bones. All the scales discovered were on the lower surface of the body, the bones lying above them except in one or two spots where a bone had, by pressure, been forced through the dermal covering. The original surface exposed was afterwards increased in extent, until a total continuous area of thirty-three and one-third square inches was uncovered. This surface contains an average of ninety scales to the square inch, or a total of 3,000 scales. These are all preserved upon a single block of limestone, which also contains several vertebræ, phalanges, and other bones. A comparison with the scales of the living rattlesnake of the plains (Crotalus confluentus Say), indicates that the scales of the saurian were somewhat smaller than those of the snake, which, in a full-grown "rattler," average eighty to the square inch, instead of ninety.

On the day after the discovery of this dermal surface, I determined to obtain the remainder of the saurian, which was imbedded in the solid rock. It was necessary to remove eight feet of superincumbent material before the proper level or "horizon" was reached, and also to undermine the specimen, in order to secure the remains in their original position, and, if possible, to expose a larger portion of the dermal covering. After three days and a half of hard labor, by myself and two assistants, we succeeded in removing one large slab, five and one-half feet by two and one-half feet, and six inches in thickness, weighing 500 lbs., and two smaller slabs, each containing the bones of a hind leg and foot. The large slab was found to contain dorsal vertebræ, ribs and pelvic bones, in perfect preservation and apparently without distortion. It also contains one of the forward limbs, or hands, lying underneath the ribs and vertebræ, with the bones in natural

position. In this hand there are forty-seven of the hour-glass-shaped bones of the palm and fingers, the five series consisting respectively of twelve, eleven, ten, eight, and six bones. The terminal or twelfth bone of the first series is very minute, and triangular in shape, or, more exactly, shaped like the half of an hour-glass.

No attempt has yet been made to expose the dermal covering contained in the large slab, and it is exceedingly doubtful if such an attempt would prove successful. The bones imbedded in this slab, and now brought out in relief, are not in their natural position except those of the hand above mentioned. Only two of the twenty vertebræ, which are scattered over the slab in all positions, remain united. The dozen ribs are variously disposed, and one of the thigh bones occupies a spot not far from the center of the lower margin of the slab. The appearance is very much as if some more powerful saurian or shark had devoured the flesh upon the larger bones of the victim, leaving untouched a portion of the skin of the lower surface of the body, and one of the front paddles, which probably did not contain much material for the gratification of his appetite.

In regard to the generic determination of this saurian, I can only say, that of the three well marked genera of the mosasauroid reptiles of the Kansas cretaceous, the specimen seems to agree most accurately with Liodon Owen (Tylosaurus Marsh). This genus is indicated by the broad neural spines, and by the fact that the number of bones in the first digit of the paddles is the greatest. The specific determination given in the title of this paper will probably be found to be correct. The specimen appears to be a small-sized individual of its species. It is possible that the species may prove to be micromus instead of dyspelor.

Front Paddle of *Liodon*, as drawn by W. H. Simpson

The following measurements are appended:

	M.
Dermal scale—	
Length	.0033
Breadth	.0025
Length of "carina"	.0037
Dorsal vertebra—	
Length of centrum	.075
Length of neural spine	.095
Breadth of neural spine, at base	.074
Breadth of neural spine, at tip	.039
Vertical diameter of cup	.058
Transverse diameter of cup	.071
Longest rib—	
Tip to tip	.381
Along curvature	.418
Breadth at base	.025
Breadth at tip	.009
Breadth at center	.012
Femur—	
Length	.132
Breadth at proximal end	.082
Breadth at distal end	.073
Breadth at center	.050
Front paddle—total length	.726
Coracoid—	
Length	.118
Breadth at proximal end	.131
Curvature at proximal end	.195
Breadth at distal end	.056
Distance of perforation from outer edge	.026
Distance of perforation from inner edge	.042
Humerus—	
Length	.122
Breadth at proximal end	.074
Breadth at distal end	.080
Ulna—	
Length	.093
Breadth, proximal	.041
Breadth, distal	.063
Radius—	
Length	.094
Breadth, proximal	.047
Breadth, distal	.041

In the plates which accompany this article, the dermal scales are represented of natural size, and the slab containing the bones is reduced to one-ninth its natural dimensions.

THE IOLA (KANSAS) MINERAL WELL.

By Prof. William K. Kedzie.

At the request of the proprietors, I visited this interesting phenomenon during the month of June, 1876, for the purpose of collecting a supply of

water for a thorough analysis. The so-called "well" is, as is well known, simply an old boring by coal prospectors. Its total depth is 736 feet. When at the depth of 626 feet the diamond drill with which the boring was made, suddenly dropped some twenty inches through an apparently vacant seam. A violent upward rush of water and gas immediately began through the tube, and with more or less irregularity has since continued without cessation. The boring is tubed to the depth of 149 feet only. The water is expelled by the elastic force of the gas in very irregular pulsations, at varying intervals alternately first with great impetus and then with a succession of fainter impulses. The sections of the core obtained during the boring present, when arranged in order, a most interesting view of the geological section of this region; especially instructive as it occurs over the Lower Coal Measure area of this State. The water of the well is, of course, largely charged with mineral matters, a portion of which being held in solution by the free carbonic acid with which the water abounds, is deposited as a thick sediment upon allowing the water to stand for some time freely exposed to the open air. By repeated and careful experiments, I determined the temperature of the water to be uniformly 61° F., as from the great depth from which the water rises it exhibits little or no variation in temperature through summer or winter. A full analysis of the water presents the following results: Specific Gravity, 1.0138. Temperature, 61° F. Total Mineral Matter to the Imperial Gallon, 1100.081 grains. Carbonic Acid Gas, 145.881 cub. in.

Sodium Chloride	971.506 Grains.
Potassium Chloride	17.909 "
Magnesium Chloride	7.305 "
Sodium Bi-carbonate	8.158 "
Calcium Bi-carbonate	60.687 "
Magnesium Bi-carbonate	25.485 "
Iron Bi-carbonate	3.939 "
Silica	.602 "
Sodium Iodide	Distinct Traces.
Sodium Bromide	Abundant "
Organic Matter	2.000 Grains.
Suspended Matter	3.500 "
Total	1100.081 Grains.

The results of the above analysis have been in all cases duplicated, and in many cases triplicated. Like the product of all mineral wells, this water of course varies somewhat, within slight limits, in its composition. Thus in the water examined by me there was absolutely no trace whatever of sulphates, whereas I observe that Prof. G. E. Patrick, in his paper read before the Academy last year, reports the presence of a very small quantity of Sodium Sulphate. I notice, however, that Mr. Patrick also reports in his analysis an appreciable quantity of Ferric Chloride (Sesqui-Chloride of Iron). If this salt of iron is indeed present in this water it is a most remarkable fact, as there is no well authenticated analysis showing its existence in any mineral spring in the United States. My own analysis indicates no such condition, the iron being present in the water analyzed by me in its usual form in all mineral waters, viz., held in solution as the Bi-carbonate. For the purpose of comparison I give below a tabular view showing the composition of the Iola water as contrasted with that of two of the most noted of the Saratoga Springs, the "Congress" and the "United States."

IN GRAINS TO THE IMPERIAL GALLON.

	Iola	Congress	United States
Bi-carbonate of Sodium	8.158	7.473	3.240
Bi-carbonate of Calcium	60.687	99.593	64.672
Bi-carbonate of Magnesium	25.485	72.152	43.192
Bi-carbonate of Iron	3.929	.248	.520
Bi-carbonate of Lithium	.....	2.992	3.040
Bi-carbonate of Barium	.....	.760	.752
Chloride of Sodium	971.506	400.440	141.872
Chloride of Potassium	17.909	8.048	8.604
Chloride of Magnesium	7.305	.....	.....
Sulphate of Potassium	.....	.888	.....
Phosphate of Sodium	.....	.016	.016
Iodide of Sodium	Traces.	.136	.048
Bromide of Sodium	Traces.	8.552	.848
Alumina	.....	Traces.	.096
Silica	.602	.840	3.184
Organic Matter	2.000	Traces.	Traces.
Cabonic Acid Gas (cubic inches)	145.891	432	240

The Iodide and Bromide of Sodium, though in minute amount, are present in very appreciable quantities in the water of the Iola well, and to their influence is undoubtedly due much of the asserted beneficial effects of this water upon scrofulous and other allied difficulties. The Carbonic Acid present in the Iola water is considerably less than that afforded in the waters of the Saratoga Springs, though an abundance is present to remove, by its sparkling influence, much of the disagreeable flavor of the water, which otherwise, from the large amount of mineral matter present, might prove somewhat unpleasant.

The gas which is thrown from the well with such force and in such quantity, is almost wholly made up of Light Carburetted Hydrogen, commonly known as "Marsh Gas." From its very slight solubility (1 part in 27 by volume, Storer), it of course exists in very small quantities only in the water itself, though it is constantly bubbling up through it. Notwithstanding the views of many observers and writers, the escape of this gas in such abundance from this well is neither anomalous nor startlingly unusual. It is no uncommon occurrence in many portions of the country in sinking similar borings for coal, salt or oil, to find this gas suddenly escaping with force sufficient to stop or reverse the engine. This Light Carburetted Hydrogen is produced in immense quantities in nature from the slow decomposition of all deposits of vegetable matter, and frequently escapes naturally in great abundance. The large supply of this gas near Fredonia, N. Y., by which the entire village is lighted, is too well known to need comment here. Near Oberlin, Ohio, is a spring from which I have frequently discovered the gas escaping in great quantity, forming, when lighted, a flame of large size. Near Kanawha, Va., and at many other places too numerous to mention, this same gas has been known to escape for years without cessation. It is this gas which constitutes the dreaded "fire damp" of our coal mines, the cause of all the terrible disasters and explosions with which the history of coal mining is filled. Points from which it escapes in much the same manner as at Iola, without the efflux of water, are known to the miners as "blowers," and are liable to suddenly appear at any time upon opening a new seam.

Nor, upon the other hand, is it at all necessary, in endeavoring to explain the origin of such large quantities of this gas as escape from the Iola

boring, to resort to the popular but very improbable hypothesis of the decomposition of the coal itself by the agency of heat; especially inapplicable to this uniformly undisturbed portion of the Lower Coal Measure of Kansas. There is no evidence to show that this vacant seam of twenty inches encountered at this great depth was originally occupied by a coal bed at all, and such a supposition is not in any way essential. There can be no doubt but that this opening, whether produced by flexure of lower strata or otherwise, communicates laterally with a very large tract of coal-bearing formations, possibly with a good portion of the Western Interior Coal area. And when we remember the fact that this Light Carburetted Hydrogen is given off in large quantities from many varieties of bituminous coal at ordinary temperatures, we need be at no loss to account for its appearance at this opening in such considerable amount. It is from this cause that the gas accumulates in coal mines in such dangerous quantities; and it is by no means impossible that this Iola boring may serve as the "vent hole" for a considerable area of coal-bearing territory. This escape of Light Carburetted Hydrogen from soft bituminous coal at ordinary temperatures is of course a continuation of the original coal-forming process; a slow decomposition of vegetable matter under a very limited supply of atmospheric oxygen, in which the gaseous products are principally Light Carburetted Hydrogen with Carbonic Acid (di-oxide), small portions of Carbonic Oxide and occasionally still smaller quantities of free Hydrogen. The appearance of the Light Carburetted Hydrogen in so liberal quantities at the Iola well, as also the composition of the water brought up by the pulsations of the gas itself, are both matters of very great scientific interest; but neither their interest nor their importance are in any way augmented by ascribing miraculous properties to the one or an anomalous origin to the other.

THE INSECTS OF WALLACE COUNTY, KANSAS.

By Prof. F. H. Snow, of the University of Kansas.

The Kansas University Scientific Expedition for 1877, in charge of the writer, spent three weeks in camp along the Smoky Hill river, about one mile from Fort Wallace. The elevation of this locality, above the level of the sea is about 3,700 feet. Wallace county is the extreme western county of the State, along the line of the Kansas Pacific Railway. The railway station is 420 miles, by rail, from Kansas City, and 219 miles from Denver. Our collecting ground was therefore very near the center of the plains, or of what was once known as the Great American Desert. The expedition for 1878 spent one month (June 12th to July 12th) in Gove and Wallace counties. Gove county adjoins Wallace county on the east, and the altitude of the railway station at Buffalo is about 3,300 feet above the level of the sea. As the two counties are contiguous, and as their faunal characteristics are apparently identical, the collections of both expeditions are combined in one list. Species taken in Wallace county alone, are marked "W."; those taken in Gove county, alone, are marked "G.", and those taken in both counties are not marked for locality. In the present paper, I include only the orders Lepidoptera and Coleoptera.

My assistants in 1877, were Messrs. Richard Foster and John M. Walker; in 1878, Richard Foster and Louis L. Dyche. To their indefatiga-

ble industry I am largely indebted for the valuable results of the expeditions. I am also indebted to the kindness of Dr. Jno. L. LeConte, of Philadelphia, for the determination of Coleoptera not previously known to me.

LIST OF LEPIDOPTERA.

Pieris protodice Bd.-Lec. G.
Nathalis Iole Bd. W.
Colias Eurytheme Bd.
Danais Archippus Fabr.
Argynnis Idalia Drury. G.
Euptoieta Claudia Cram. W.
Phyciodes Tharos Drury. W.
Phyciodes Nycteis Doubl. W.
Grapta interrogationis Fab. var. umbrosa Lintner.
Vanessa Antiopa L. W.
Pyrameis Atalanta L.
Pyrameis cardui L.
Paphia glycerium Doubl. W.
Satyrus Alope Fabr. W.
Thecla humuli Harr.
Lycaena Melissa Edw.
Lycaena acmon West.-Hew. W.
Lycaena Alce Edw. G.
Pamphila Uncas Edw.
Pyrgus tessellata Scud.
Pholisora Catullus Cram. G.
Deilephila lineata Fabr. W.
Proserpinus gauræ Sm.-Abb. W.
Ægeria sp. Three undescribed species. W.
Cerura n. sp. W.
Agrotis Harveyi Grote. W.
Aletia argillacea Hubn. W.
Plusia gamma Linn. W.

Acopia perpallida n. sp. Grote. This species has been described by Prof. Grote in the "Canadian Entomologist" (Vol. X, p. 68), as follows:

"Larger than carina, with white secondaries. Primaries white, shaded with ochrey and with narrow fuscous lines. Basal line indicated; anterior line upright, forming two large teeth; outer line denticulate, outwardly produced opposite the cell; orbicular obsolete; reniform concolorous, obscured by a dark shade. Subterminal shade line fuscous, even, continued to vein 7 from internal angle, above which it appears as an inwardly oblique shade from costa to vein 7. A terminal interrupted line; fringes white. Hind wings white, very slightly soiled, with discal mark and in distinct line; fringes white. Beneath yellowish white, shaded with fuscous on primaries; fringes white. Body whitish. Expands 28 mil.

"The median lines on primaries are further apart than in carina. This species was sent me by Prof. Snow under the number 504."

Alaria gauræ Sm. W.
Euleucyptera cumatilis Grote. W.
Lygranthæcia jaguarina Guen. W.
Heliochilus paradoxus Grote. W.
Tarache lactipennis Harvey. W.
Drasteria erichtea Cramer.
Brotis vulneraria Hubn. W.

Catocala Nebraskæ Dodge. W.
Catocala amatrix Hub. var. nurus Walk. W.
Catocala Ilia Cram. G.
Syneda Howlandi Grote. W.
Stegania pustularia Guen. W.
Hæmatopis grataria. Fab.
Conchylis Ridingsana Rob. W. Number of species, 45.

LIST OF COLEOPTERA.

(The numbers are those of Crotch's check-list.)

CICINDELIDÆ.

1. Amblychila cylindriformis Say.
14. Cicindela pulchra Say.
15d. Cicindela scutellaris Say.
22. Cicindela purpurea Oliv. var. Audubonii Lec.
25. Cicindela formosa Say.
—. Cicindela venusta Lec. W.
27. Cicindela fulgida Say. W.
43. Cicindela cuprascens Lec. G.
46. Cicindela sperata Lec. G.
51. Cicindela punctulata Fab.
—. Cicindela micans Fab.
—. Cicindela circumpicta Laf. W.

CARABIDÆ.

73. Omophron tessellatum Say. W.
134. Calosoma scrutator Fab. G.
141. Calosoma obsoletum Say.
200. Pasimachus elongatus Lec.
201. Pasimachus punctulatus Hald. W.
318. Galerita janus Fab. W.
329. Casnonia Pennsylvanica L. W.
340. Loxopeza grandis Hentz.
382. Blechrus linearis Lec. G.
386. Axinopalpus biplagiatus Dej. G.
393. Glycia viridicollis Lec. W.
398. Cymindis brevipennis Zimm.
461. Platynus extensicollis Say. W.
463. Platynus decorus Say. W.
498. Platynus nutans Say. G.
561. Evarthrus substriatus Lec.
618. Pterostichus scitulus Lec. G.
—. Amara sp. An undescribed species. W.
694. Amara impuncticollis Say. W.
699. Amara fallax Lec.
703. Amara convexa Lec. W.
709. Amara obesa Say. W.
710. Amara diffinis Lec. W.
795. Chlænius tomentosus Say.
818. Cratacanthus dubius Beauv.
824. Agonoderus comma Fab. G.
871. Anisodactylus sericeus Harr. G.
916. Selenophorus pedicularis Dej.

917. Selenophorus troglodytes Dej. G.
928. Harpalus caliginosus Fab. W.
933. Harpalus compar Lec. G.
942. Harpalus ventralis Lec. W.
976. Stenolophus conjunctus Say.
1080. Bembidium cordatum Lec. G.
1097. Bembidium intermedium Kby. G.

HALIPLIDÆ.

1183. Cnemidotus 12-punctatus Say.

DYTISCIDÆ.

1185. Eretes sticticus Linn. G.
1208. Hydroporus patruelis Lec. G.
1210. Hydroporus nubilus Lec. G.
1236. Hydroporus undulatus Say. G.
1279. Laccophilus proximus Say. G.
1283. Laccophilus 4-lineatus Horn. G.
1291. Thermonectes ornaticollis Aube. G.
1338. Coptotomus interrogatus Fab. G.
1347. Guarodytes disintegratus Cr. G.

GYRINIDÆ.

1389. Dineutus assimilis Aube.
1402. Gyrinus parcus Say. G.

HYDROPHILIDÆ.

1423. Helophorus lineatus Say. G.
1449. Hydrophilus triangularis Say. G.
1450. Tropisternus nimbatus Say. G.
1454. Tropisternus sublævis Lec. G.
1461. Hydrocharis obtusatus Say. G.
1465. Berosus miles Lec. G.
1477. Berosus striatus Say. G.
1499. Philhydrus perplexus Lec.
1504. Philhydrus fimbriatus Mels. G. Taken by S. W. Williston.
1516. Hydrobius subcupræus Say. G.

STAPHYLINIDÆ.

1712. Tachyporus chrysomelinus Linn. G.
1771. Creophilus villosus Grav.
——. Philonthus fusiformis Fauvel MS. G.
1884. Cryptobium bicolor Grav. W.

SILPHIDÆ.

2175. Silpha carolina Linn. W.
2176. Silpha marginata Fab.
2185. Silpha tomentosa Web. W.
2188. Peltis lapponica Hb. W.
2194. Peltis truncata Say. W.
2196. Peltis Americana Linn. W.
——. Agathidium sp. W.

DERMESTIDÆ.

2392. Dermestes marmoratus Say. G.

2394. Dermestes fasciatus Lec. W.
2395. Dermestes nubilus Say.
——. Attagenus sp. G.

TRITOMIDÆ.

2474. Typhæa fumata Linn. G.

EROTYLIDÆ.

2506. Languria Mozardi Latr. W.
2511. Languria læta Lec. G.
2514. Languria gracilis Newm. G.

NITIDULIDÆ.

2725. Carpophilus niger Say. Taken by S. W. Williston.
2755. Nitidula ziczac Say.

PHALACRIDÆ.

——. Olibrus sp. G.

COCCINELLIDÆ.

2830. Hippodamia glacialis Fab.
2832. Hippodamia convergens Guer.
2837. Hippodamia parenthesis Say.
2847. Coccinella 9-notata Hb.
2853. Cycloneda sanguinea Linn. G.
2854a. Cycloneda abdominalis Say. G.
2876. Brachyacantha dentipes Fab. G.
2897. Hyperaspidius trimaculata Linn. G.
2924. Scymnus cervicalis Muls. G.

HETEROCERIDÆ.

——. Heterocerus sp. G.

HISTERIDÆ.

3037. Hister Harrisii Kby.
——. Hister binotatus Lec.
3131. Saprinus lugens Er. W.
3133. Saprinus Pennsylvanicus Payk.
3158. Saprinus fimbriatus Lec.

SCARABÆIDÆ.

3223. Canthon ebenus Say.
3230. Canthon hudsonias Forst. W.
3241. Phanæus carnifex Linn. W.
3244. Onthophagus latebrosus Fab. W.
3268. Aphodius granarius Linn. G.
3283. Aphodius stercorosus Mels. W.
3291. Aphodius concavus Say. G.
——. Atænius sp. G.
3351. Bolboceras farctus Fab. W.
3352. Bolboceras lazarus Fab. W.
3377. Trox suberosus Fab.
3379. Trox punctatus Germ. W.
3381. Trox Sonoræ Lec.
3394. Trox atrox Lec. W.

3482. Diplotaxis pacata Lec.
3484. Diplotaxis Haydenii Lec. G.
3518. Lachnosterna crassissima Blanch. G.
3519. Lachnosterna prunina Lec. G.
3520. Lachnosterna rugosa Mels. G.
3545. Lachnosterna glabricula Lec. W.
3564. Tostegoptera lanceolata Say.
3566. Polyphylla Hammondi Lec. W.
3588. Strigoderma arboricola Fabr. G.
3609. Ligyrus gibbosus De Geer.
3614. Aphonus pyriformis Lec. W.
3645. Euryomia Kernii Hald. G.
3646. Euryomia inda Linn. W.
3650. Euryomia fulgida Fabr. G.
3654. Cremastochilus saucius, Lec. W.
3659. Cremastochilus Knochii, Lec.

BUPRESTIDÆ.

3692. Dicerca obscura Fab. W.
3707. Poecilonota cyanipes Say. W.
3791. Acmæodera pulchella Hbst. G.
3827. Agrilus pubiventris Cr.
3833. Agrilus muticus Lec.

ELATERIDÆ.

3925. Lacon rectangularis Say.
4050. Drasterius dorsalis Say. G.
4090. Monocrepidius auritus Hbst. G.
4154. Melanotus verberans Lec. G.
——. Melanotus sp. G.
4355. Melanactes puncticollis Lec.

LAMPYRIDÆ.

4448. Lucidota punctata Lec. G.

TELEPHORIDÆ.

4481. Chauliognathus basalis Lec.
4526. Telephorus flavipes Lec. G.
4561. Ditemnus bidentatus Say. W.

MALACHIDÆ.

4582. Collops bipunctatus Say. W.
4584. Collops 4-maculatus Fab. var.
4589. Collops limbatus Lec. G.

CLERIDÆ.

——. Clerus n. sp.
4722. Clerus Spinolæ Lec. G.
4734. Clerus cordifer Lec. W.
4740. Clerus thoracicus Oliv. G.
4765. Hydnocera tabida Lec. G.
4791. Corynetes rufipes Fab.

CERAMBYCIDÆ.

4919. Prionus imbricornis Linn. G.

4920. Prionus fissicornis Hald.
5077. Batyle ignicollis Say. G.
5081. Batyle Pearsalli Bland. G.
5091. Crossidius pulchellus Lec. W.
5094. Crossidius discoideus Say. W.
5104. Cyllene decorus Oliv. var. infaustus Lec. G.
5221. Typocerus velutinus Oliv.
5224. Typocerus sinuatus Newm. A black variety of this species also occurs.
5306. Monilema annulatum Say.
5404. Ataxia crypta Say. W.
5424. Mecas inornata Say.
5426. Mecas gentilis Lec. G.
5433a. Oberea basalis Lec. G.
5436. Oberea oculaticollis Say. G.
5445. Tetraopes tetraophthalmus Forst. W.
5447. Tetraopes quinquemaculatus Hald.
5448. Tetraopes femoralis Lec.

SPERMOPHAGIDÆ.

5472. Bruchus discoideus Say.
5481. Bruchus pruininus Horn. Taken by S. W. Williston.
5496. Bruchus fraterculus Horn.
5506. Bruchus seminulum Horn. W.

CHRYSOMELIDÆ.

5550. Lema collaris Say. W.
5554. Lema trinileata Oliv. var. G.
5563. Saxinis omogera Lac. G.
5569. Coscinoptera axillaris Cr.
5571. Coscinoptera dominicana Fab. G.
5595. Cryptocephalus confluens Say. W.
5631. Pachybrachys viduatus Fab. G.
5661. Pachybrachys litigiosus Suffr.
5664. Pachybrachys hepaticus Mels. G.
——. Pachybrachys sp. Two undescribed species.
5687. Myochrous squamosus Les. G.
5693. Chalcoparia globosa Oliv. G.
5694. Paria 6-notata Say. G.
5714. Colaspis favosa Say. G.
5715a. Colaspis flavida Say. W.
——. Colaspis flavida Say, var. lineata. G.
5716. Colaspis pretexta Say. G.
5719. Colaspis tristis Oliv. var.
5724. Chrysomela 10-lineata Say. G.
5729. Chrysomela exclamationis Fab.
5733. Chrysomela disrupta Rog. G.
5741. Chrysomela multipunctata Say. W.
5766. Plagiodera lapponica Linn. G.
5772. Plagiodera oviformis Lec. G.
5800. Diabrotica tricincta Say. W.
5802. Diabrotica 12-punctata Oliv.
5805. Diabrotica blandula Lec.
5831. Monoxia guttulata Lec. G.
5834b. Trirhabda Canadensis Kby. G.

5838. Trirhabda nitidicollis Lec. W.
5851. Œdioychis vians Ill. W.
5865. Disonycha alternata Ill. W.
5870. Disonycha abbreviata Mels.
5873. Disonycha triangularis Say.
5882. Graptodera torquata Lec. Taken by S. W. Williston.
5886. Graptodera foliacea Lec.
5904. Orchestris vittata Fab. G.
——. Orchestris sp. G.
5912. Aphthona Texana Cr. W.
5928. Crepidodera Helxines Linn. G.
5941. Chætocnema subviridis Lec. G.
5942. Chætocnema denticulata Ill. G.
5969. Microrhopala cyanea Say. W.
5977. Chelimorpha Lewisii Cr. W.
5980b. Cassida ellipsis Lec.

TENEBRIONIDÆ.

6002. Trimytis pruinosa Lec. W.
6010. Epitragus canaliculatus Say. W.
6068. Asida opaca Say.
6070. Asida polita Say. W.
6071. Asida sordida Lec. W.
6092. Asida convexa Lec. W.
6097. Asida elata Lec. W.
6098. Ologlyptus anastomosis Say.
6105. Eusattus reticulatus Say. G.
6128. Eleodes acuta Say.
6129. Eleodes suturalis Say.
6129a. Eleodes Texana Lec.
6131. Eleodes tricostata Say.
6133. Eleodes obsoleta Say.
6137. Eleodes extricata Say.
6141. Eleodes longicollis Say.
6150. Eleodes hispilabris Say.
6167. Eleodes opaca Say.
6174. Embaphion muricatum Say. W.
6175. Embaphion contusum Lec. G.
6222. Tenebrio obscurus Fab. G.
6244. Blapstinus pratensis Lec.
6245. Blapstinus vestitus Lec. W.

ALLECULIDÆ.

6375. Hymenorus obscurus Say. W.

ANTHICIDÆ.

6458. Notoxus subtilis Lec.
——. Notoxus sp. W.

MORDELLIDÆ.

6583. Anaspis rufa Say. G.
6593. Mordella melæna Germ.
6594. Mordella scutellaris Fabr. G.
6602. Mordella oculata Say. G.
6648. Mordellistena unicolor Lec.
6662. Mordellistena suturella Helmuth. G.

MELOIDÆ.

6711. Tricrania Stansburii Hald. G.
6713. Macrobasis albida Say. W.
6721. Macrobasis fulvescens Lec. W.
6722. Macrobasis segmentata Say.
——. Epicauta trichrus var. G.
6731. Epicauta ferruginea Say.
6732. Epicauta sericans Lec. W.
6738. Epicauta maculata Say.
6746. Epicauta corvina Lec. W.
6747. Epicauta Pennsylvanica DeG. W.
6750. Pyrota mylabrina Chev. W.
6779. Cantharis reticulata Say. W.
6803. Zonitis atripennis Say. W.
6807. Nemognatha sparsa Lec. W.
6808. Nemognatha bicolor Lec. W.
6809. Nemognatha lurida Lec.
6810. Nemognatha apicalis Lec.
6816. Nemognatha piezata Fabr. W.
6825. Nemognatha immaculata Say. W.
6830. Gnathium minimum Say.

RHYNCHITIDÆ.

Rhynchites hirtus Oliv.

BYRSOPIDÆ.

Thecesternus humeralis Say, race rudis Lec.

OTIORHYNCHIDÆ.

Epicærus imbricatus Say.
Ophryastes vittatus Say. W.
Ophryastes tuberosus Lec.
Ophryastes sulcirostris Say. W.
Phacepholis elegans Horn.

CURCULIONIDÆ.

Sitones tibialis Germ.
Phytonomus eximius Lec. G.
Listronotus sp. G.
Cleonus trivittatus Say. G.
Cleonus frontalis Lec. W.
Lixus terminalis Lec. G.
Lixus mucidus Lec. G.
Dorytomus squamosus Lec. G.
Smicronyx fulvus Lec. W.
Endalus limatulus Lap. G.
Anthonomus fulvus Lec.
Anthonomus squamosus Lec.
Anthonomus sp. G.
Macrorhoptus estriatus Lec.
Rhyssematus lineaticollis Say.
Acalles turbidus Lec.
Tyloderma foveolatum Say. G.
Copturus operculatus Gyll.
Ceutorhynchus sp. G.

Ceutorhynchus decipiens Lec.
Rhinoncus pericarpius Gyll. G.
Rhinoncus pyrrhopus Boh. G.
Orthoris Crotchii Lec. G.
Trichobaris trinotata Say. G.
Baris transversa Say. W.
Baris macer (?). G.
Baris pruinosa Lec. G.

CALANDRIDÆ.

Sphenophorus vomerinus Lec. var. baridioides.
Rhodobænus 13-punctatus Ill.
Cossonus corticola Say. W.

APIONIDÆ.

Apion sp. An undescribed species.

SUMMARY OF SPECIES OF COLEOPTERA.

Cincindelidæ	10	Lampyridæ	1
Carabidæ	35	Telephoridæ	3
Haliplidæ	1	Malachidæ	3
Dytiscidæ	9	Cleridæ	6
Gyrinidæ	2	Cerambycidæ	18
Hydrophilidæ	10	Spermophagidæ	4
Staphylinidæ	4	Chrysomelidæ	46
Silphidæ	7	Tenebrionidæ	23
Dermestidæ	4	Alleculidæ	1
Tritomidæ	1	Anthicidæ	2
Erotylidæ	3	Mordellidæ	6
Nitidulidæ	2	Meloidæ	20
Phalacridæ	1	Rhynchitidæ	1
Coccinellidæ	9	Byrsopidæ	1
Heteroceridæ	1	Otiorhynchidæ	5
Histeridæ	5	Cucullionidæ	27
Scarabæidæ	30	Calandridæ	3
Buprestidæ	5	Apionidæ	1
Elateridæ	6		
Total		Families, 37; Specie	316

LIST OF LEPIDOPTERA.

Collected in Colorado in June, July and August, 1876, by the Kansas University Scientific Expedition.

By Prof. F. H. Snow.

A list of the Coleoptera taken in Colorado by the expedition in my charge, was published in Vol. V of the Transactions of this Academy (pp. 15—20). The following Lepidoptera were collected by the same party. For the determination of species previously unknown to me, I am indebted to Wm. H. Edwards, Esq., of Coalburgh, West Va., and to Prof. A. R. Grote, of Buffalo, N. Y. Included also in this list are a few additional species taken in Platte Canon, in July, 1878.

LEPIDOPTERA RHOPALOCERA.

Papilio Zolicaon Bdl. A single specimen was taken in Platte Canon at an altitude of 8,000 feet.

Papilio Eurymedon Bdl. Found in considerable numbers at an elevation of 8,000 to 10,000 feet, about the summits of rocky peaks.

Papilio Rutulus Bdl. Taken in open woods along the Ute Pass road—7,000 to 9,000 feet.

Papilio Daunus Edwards. Not uncommon in Engelmann's Canon and other canons, at an altitude of 6,000 to 8,000 feet. This species is very swift in flight, and exceedingly difficult to capture.

Parnassius Smintheus Doub. Found at all elevations from 7,000 to 13,000 feet. Specimens from above timber line on Pike's Peak, have the wings nearly transparent. One or two examples of var. Behrii Edw., were captured on Pike's Peak.

Pieris Protodice Bdl.-Lec. Common at Colorado Springs, in Engelmann's Canon, and at other low elevations.

Pieris oleracea Bdl. Only two or three specimens were seen—these being at an elevation of 9,000 feet.

Nathalis Iole Boisd. Taken occasionally at low elevations.

Colias Eurytheme Bdl. Taken at all elevations below 10,000 feet. Var. Keewaydin Edw., also occurred.

Colias Meadii Edw. Abundant above timber line on Pike's Peak—altitude 13,000 feet.

Colias Alexandra Edw. Taken along the Upper Arkansas, also in Platte Canon, near Dome Rock, at an altitude of 7,500 feet.

Colias Philodice Godart. Specimens of this species differ somewhat from the Eastern form, and are considered by Mr. W. H. Edwards to constitute a distinct species.

Terias Mexicana Bdl. Taken in Jones's Park, along the Signal Service Trail to Pike's Peak, also near Dome Rock in Platte Canon.

Danais Archippus Fab. Found at all elevations up to timber line.

Euptoieta Claudia Cramer. Found abundantly at some elevations with the last species.

Argynnis Aphrodite Fab. var. Alcestis Edw. Common in Engelmann's Canon, and Platte Canon, at middle elevations.

Argynnis Edwardsii Reakirt. Frequent in same localities with the preceding.

Argynnis Meadii Edw. Taken in the Platte Canon.

Argynnis Eurynome Edw. A single specimen was obtained in the Upper Arkansas valley.

Argynnis Helena Edw. Found at high elevations, extending above the timber line nearly to the summit of Pike's Peak, 14,000 feet above the sea.

Melitæa nubigena Behr. Taken at all elevations from 7,000 feet to timber line. I am unable to detect any specific difference between this species and M. Anicia Doub.

Melitæa Gabbii Behr. This species had not previously been taken in Colorado. Only one specimen was secured—below timber line on Pike's Peak.

Melitæa minuta Edw. Not before taken in Colorado. Several specimens were obtained by our party in the South Park.

Phyciodes Tharos Drury, var. Marcia Edw. Common in the Ute Pass.

Phyciodes Camillus Edw. Abundant in the canons at low and middle elevations.

Grapta Satyrus Edw. A rare species, though found in three different localities, Engelmann's Canon, Clear Creek Canon, and Platte Canon.

Grapta Zephyrus Edw. Common along the Ute Pass road.

Vanessa Antiopa Linn. Not common, but quite generally distributed at low and middle elevations.

Vanessa Milbertii Godt. Rarely seen at all elevations. Two fresh

specimens were taken above timber line on Pike's Peak, at an elevation of 13,000 feet.

Pyrameis cardui L. A single specimen of this "cosmopolitan" was taken above timber line on Pike's Peak. It was often seen at lower elevations.

Junonia Lavinia Cram. Platte Canon, near "Dome Rock."

Limenitis Weidemeyerii Edw. Common in Engelmann's Canon and along the Ute Pass road, at an elevation of 8,000 feet.

Cænonympha ochracea Edw. Taken frequently along the Ute Pass road, and in South Park.

Satyrus nephele Kirby. A single specimen was taken in Platte Canon.

Satyrus Charon Edw. Found abundantly in Engelmann's and Platte Canons, at 6,000 to 8,000 feet elevation.

Satyrus Meadii Edw. Taken frequently in Platte Canon, at 6,000 to 8,000 feet elevation.

Satyrus Ridingsii Edw. Abundant on the plains about Colorado Springs.

Erebia Epipsodea Butler. Found in the small canons along the east border of South Park, at an elevation of 9,000 to 10,000 feet.

Chionobas Uhlerii Reakirt. Taken rarely along the Ute Pass road, at low elevations.

Chionobas Chryxus West.-Hew. More common than the preceding, and reaching to higher elevations.

Chionobas semidea Say. Seen abundantly on the summit of Pike's Peak, 13,000 to 14,000 feet elevation.

Thecla Crysalus Edw. Taken abundantly on oaks in Engelmann's and Platte Canons, at 6,000 to 8,000 feet elevation.

Thecla Strigosa Harr. Not before taken in Colorado.

Thecla Calanus Hub. Not previously taken in Colorado.

Thecla Sæpium Bd.

Thecla Behrii Edw. Not previously recorded from Colorado. This and the three preceding species were taken in Platte Canon at an altitude of 7,000 feet.

Thecla Mopsus Hubner. Taken along the Ute Pass road, near the South Park.

Thecla Eryphon Bd. A single specimen—locality not noted.

Chrysophanus Nais Edw. Taken in the Platte Canon; not previously reported from Colorado.

Chrysophanus Ianthe Edw. One specimen was taken in the Upper Arkansas valley.

Chrysophanus Virginiensis Edw. Taken abundantly in Engelmann's and Platte Canons; not previously recorded from Colorado.

Chrysophanus Sirius Edw. A single specimen was taken in Engelmann's Canon.

Lycæna heteronea Bdl. One specimen only, taken at Dome Rock in Platte Canon.

Lycæna Lycea Edw. Common about Colorado Springs; taken also in South Park.

Lycæna Sæpiolus Bd. var. Aehaja Behr. South Park.

Lycæna Orbitulus Von Prunner. Taken along the upper portion of the Ute Pass road.

Lycæna Glaucon Edw. One or two specimens only were taken in the South Park.

Lycæna Melissa Edw. Common in the South Park.

Lycæna Acmon West.-Hew. Abundant at Colorado Springs and in South Park.

Lycæna Isola Peak. Colorado Springs and South Park; not common.

Ancyloxypha Hylax Edw. Several specimens were taken along the Ute Pass road.

Pamphila Hobomok Harr. Taken in Engelmann's Canon and the Ute Pass.

Pamphila Comma Linn. This species in the forms Manitoba and Nevada was obtained in the South Park in considerable numbers.

Pamphila Uncas Edw. Common about Colorado Springs and in the South Park.

Pamphila Snowi Edw. This was the only new "diurnal" taken by our expedition. It was named and described by Mr. W. H. Edwards. The following is the description as given by him in the Canadian Entomologist, Vol. IX, pp. 29, 30:

"Male—expands 1.1 inch.; size and shape of Leonardus, the hind wings somewhat less prolonged anteriorly.

"Upper side of both wings light glossy brown; primaries have five trans lucent spots, namely, one sub-apical, oblong, narrow, cut into three equal parts by the subcostal nervules; three discal, the first being at the top of the upper median interspace, small, semi-oval; the next large, irregularly quadrate, crossing the next lower interspace, and the third on sub-median interspace, less transparent, more yellow, in one example clearly defined, sub-triangular, in the other diffuse; these three spots forming an oblique line back of and below the cell; the fifth spot is at the outer end of the cell, a narrow transverse bar; the stigma long, narrow, a little sinuous on the middle, black, edged in the middle by rough dark brown scales on either side.

"Secondaries have an abbreviated discal row of indistinct, small yellow spots, placed nearly parallel to the hind margin, and restricted to the discoidal and median interspaces, or very nearly so; in the middle of the cell a small yellowish spot, almost obsolete; fringes cinereous, those of secondaries lighter than the others.

"Under side of both wings brown with a russet tint; primaries somewhat fuscous near base, in and below cell, and pale yellow in the submedian interspace; the spots repeated except the lower of the three, which is lost in the color of the interspace just mentioned; secondaries have the discal spots more distinct, yellowish, and there appear faint traces of obsolete spots which would complete the series to costal margin; the cellular spot small, distinct, rounded.

"Body above brown, below the thorax gray-brown, above the collar yellow-tipped; abdomen yellow-gray; legs brown; palpi sordid white, gray at tips; antennæ fuscous above, grayish below; club fuscous for a narrow space on upper side, elsewhere russet.

"From 2 males, sent me by Prof. F. H. Snow, and taken by him in Colorado, at Ute Pass, while in charge of the Kansas University Scientific Expedition, 1876. No others were taken, as I am informed.

"The species is near Leonardus, from which it differs in not having the basal area of primaries fulvous, in not having two spots near hind margin in the discoidal interspace, in having the spots translucent instead of fulvous, and in having a distinct spot at end of cell; the stigma of Leonar-

dus differs considerably also, being heavier, somewhat curved, and especially broken in on the lower median nervule, of which the posterior part is thrown back of the line of the remainder; the spots on disk of secondaries in Leonardus are placed as in the present species, but are larger, and either quite distinct or largely diffuse, examples varying. The under side of Leonardus is more red (cinnamon-brown), and the series of spots on secondaries is complete and distinct, as is also the cellular spot. In these wings the resemblance between the two species is closer than elsewhere. They form a very interesting group."

Mr. H. K. Morrison, in 1877, found this species quite abundantly in Southern Colorado.

Pamphila Metacomet Harr. Taken in the Chiann Canon. Not previously reported from Colorado.

Pamphila Osyka Edw. Taken along the Ute Pass road. This species is also new to the Colorado list.

Pyrgus tessellata Scud. Common at low elevations.

Nisoniades Persius Scud. Taken in Engelmann's Canon and along the Ute Pass road.

Pholisora Catullus Cram. In Engelmann's and Platte Canons.

Eudamus Tityrus Fabr. In same locality as the preceding.

LEPIDOPTERA HETEROCERA.

Sesia axillaris Grote. Two specimens were taken at Dome Rock in the Platte Canon.

Deilephila lineata Fab. Colorado Springs and Manitou.

Ægeria sp. An undescribed species, was taken in Engelmann's Canon.

Alypia octomaculata Fab. Taken in the Ute Pass, about one mile from Manitou.

Gnophæla vermiculata Grote. Common along Bear Creek on the Signal Service trail to Pike's Peak.

Ctenucha Cressonana Grote. Four specimens were taken along the Ute Pass road, at an altitude of 7,500 feet.

Anatolmis Grotei Packard. Abundant in August in the Ute Pass just beyond Manitou.

Hepialus pulcher Grote. Three specimens were taken along Ute Pass road—altitude, 7,000 feet.

Leucarctia acræa Sm. A pair was taken in a garden at Colorado Springs.

Crocota sp. An undetermined species, from Engelmann's Canon.

Nemeophila petrosa Walker. Engelmann's Canon.

Tolype velleda Stall. Engelmann's Canon.

Ecpantheria reducta Grote. A new species, taken at our camp in Engelmann's Canon, about one mile from Manitou, near the famous "Iron Spring." This locality is denoted, whenever Engelmann's Canon is given in this list as the locality of capture.

Agrotis gularis Grote. Engelmann's Canon.

Agrotis auxiliaris Grote. Engelmann's Canon.

Agrotis stigmosa Morr. Engelmann's Canon.

Hadena devastatrix Grote. Engelmann's Canon.

Plusia epigæa Grote. Engelmann's Canon.

Anarta melanopa Thunb. Taken above timber line on Pike's Peak—altitude, 13,000 feet. This species is also found upon Mt. Washington, N. H., in Labrador, and upon the Alps.

Euleucyptera cumatilis Grote. Taken at "Dome Rock" in Platte Canon—altitude, 7,500 feet.

Antaplaga dimidiata Grote. A new genus and species taken in Engelmann's Canon. The following is Prof. A. R. Grote's description, as published in the Canadian Entomologist, Vol. IX, p. 71:

"Head, thorax and basal third of fore wings white. Beyond, the wing is blackish brown, limited obliquely and a little unevenly from the white basal portion by the difference in color. A whitish subterminal shade. A discal mark obscurely indicated on the darker portion of the wing. Hind wings pale fuscous with white fringe; beneath whitish. Fore wings beneath fuscous. Expanse 30 mil. Hab. Colorado, Prof. Snow."

Melicleptria villosa Grote. A pair was taken in Engelmann's Canon.

Lygranthæcia brevis Grote. Engelmann's Canon.

Catocala Walshii Edw. Taken in Colorado Springs; also in Engelmann's and Clear Creek Canons.

Catocala aholibah Strecker. Engelmann's Canon.

Syneda Howlandii Grote. Vicinity of Colorado Springs.

Chlorosea biseriata Pack. Engelmann's Canon.

Tetracis Coloradaria Pack. Engelmann's Canon.

Endropia pectinaria. Engelmann's Canon.

Thamnonoma subcessaria Walk. Engelmann's Canon.

Eurycreon sticticalis Linn. Engelmann's Canon.

Asopia sp. An undetermined species. Engelmann's Canon.

Conchylis Ridingsana Robinson. Engelmann's Canon.

Number of species: Rhopalocera, 71; Heterocera, 33. Total Lepidoptera, 104.

LIST OF COLEOPTERA.

Collected near "Dome Rock," Platte Canon, Colorado, by the Kansas University Scientific Expedition for 1878.

By Prof. F. H. Snow.

Our collecting party spent twelve days (July 12th to 26th), in the above locality, thirty-one miles from Denver. Our camp was fixed at an estimated elevation of 7,500 feet above the level of the sea. My assistants were Messrs. Richard Foster and L. L. Dyche, students of the University. The collections consisted chiefly of plants, insects and birds. The following list is presented as a slight contribution to a better knowledge of the geographical distribution of American Coleoptera. My acknowledgments are due to Dr. John L. Le Conte and Dr. Geo. H. Horn, of Philadelphia, for the determination of species not previously in my cabinet. The numbers are those of Crotch's check-list.

22. Cicindela purpurea Oliv., var. Audubonii Lec.
30. Cincindela 12-guttata Dej.
160. Carabus tædatus Fab.
428. Calathus ingratus Dej.
514. Platynus placidus Say.
581. Pterostichus protractus Lec.
699. Amara fallax Lec.
709. Amara obesa Say.
1067. Bembidium lucidum Lec.

1723. Boletobius dimidiatus Er.
1977. Bledius ruficornis Lec.
2396. Dermestes talpinus Mann.
——. Anthrenus sp.
2434a. Orphilus subnitidus Lec.
2541. Cypherotylus Boisduvali Chev.
2681. Nemosoma cylindricum Lec.
2682. Trogosita virescens Fab.
2749. Epuræa truncatella Mann.
2755. Nitidula ziczac Say.
2767. Meligethus ruficornis Lec.
2853. Cycloneda sanguinea Linn.
2858. Harmonia picta Rand.
2882. Hyperaspis fimbriolata Mels.
2928. Scymnus lacustris Lec.
——. Aphodius rudis Lec.
3560. Listrochelus falsus Lec.
3715. Buprestis consularis Gory.
3716. Buprestis Nuttalli Kirby.
3718. Buprestis maculiventris Say.
3723. Buprestis (near) adjecta Lec.
3734. Melanophila Drummondi Kirby.
3736. Melanophila gentilis G. and H.
3738. Anthaxia inornata Rand.
3753. Chrysobothris dentipes Germ.
3791. Acmæodera pulchella Hbst.
——. Microrrhagus sp.
3902. Anelastes Drurii Kirby.
——. Corymbites n. sp.
4333. Asaphes coracinus Cand.
——. Dictyoptera rubripennis Lec.
4450. Photinus corruscus Linn.
4578. Collops eximius Er.
4628. Attalus morulus Lec.
——. Clerus n. sp.
4716. Clerus ornatus Say.
4718. Clerus Nuttalli Kirby.
4746. Clerus undulatus Say.
4821. Oligomerus sericans Mels.
4918. Prionus Californicus Motsch.
4964. Callidium hirtellum Lec.
5051. Rhopalophera longipes Say.
5077. Batyle ignicollis Say.
5081. Batyle Pearsalli Bland.
5195. Acmæops tumida Lec.
5204. Acmæops proteus Kirby.
5257a. Leptura convexa Lec.
5265. Leptura carbonata Lec.
5272. Leptura sanguinea Lec.
5276. Leptura chrysocoma Kirby.
5321. Monohammus maculosus Hald.
5323. Monohammus scutellatus Say.
5357. Sternidius alpha Say.
5388. Pogonocherus mixtus Hald.

——. Oberea quadricallosa ——.
5585a. Cryptocephalus mammifer Newm.
5614. Cryptocephalus auratus Fab.
5642. Pachybrachys atomarius Mels.
5668. Xanthonia 10-notata Say.
5672. Heteraspis marcassita Germ.
5689. Chrysochus cobaltinus Lec.
5719b. Colapsis puncticollis Say.
——. Chalcophana placida ——.
5733. Chrysomela disrupta Rog.
5837. Trirhabda convergens Lec.
5886. Graptodera foliacea Lec.
——. Graptodera bimarginata Say.
6124. Coniontis ovalis Esch.
6202. Iphthimus serratus Mannh.
6357. Helops convexulus Lec.
6374. Hymenorus pilosus Mels.
6450. Notoxa anchora Hentz.
——. Pentaria rugicollis Lec.
6578. Anaspis nigra Hald.
6583. Anaspis rufa Say.
6593. Mordella melæna Germ.
6594. Mordella scutellaris Fab.
6731. Epicauta ferruginea Say.
6809. Nemognatha lurida Lec.
6825. Nemognatha immaculata Say.
——. Mycterus n. sp.
6874. Crymodes discicollis Say.
7017. Lepyrus geminatus Say.
——. Magdalis Le Contei ——.
——. Magdalis cunneiformis ——.
7106. Balaninus nasicus Say.
——. Anthonomus squamosus Lec.
7322. Pityophthorus retusus Lec.
——. Pityophthorus sp.
7364. Tomicus pini Say.

Number of species, 99.

ADDITIONS TO THE CATALOGUE OF KANSAS COLEOPTERA.

By A. E. Popenoe, Topeka.

The following list of additions to the Catalogue of Kansas Coleoptera includes in great part the results of the collections of 1877 and 1878, made in different localities by Prof. F. H. Snow and the writer. The species were determined by Dr. John L. Le Conte, of Philadelphia, to whom thanks are due for many favors. Those species noted from Lawrence are added by Prof. Snow. The additions number 435, increasing the list total to 1711 species.

49. Cicindela lepida Dej. Lawrence; taken by A. E. Blood.
67. Cicindela Pilatii Guer. Lawrence; taken by C. B. Cramer.

221. Dyschirius haemorrhoidalis Dej. Topeka; common in mud on the creek banks.
233. Dyschirius filiformis Lec. Lawrence.
242. D. hispidus Lec. Less common than No. 221; found in the same localities.
246. Ardistomis viridis Say. Topeka and Lawrence.
252. Clivina impressifrons Lec. Lawrence.
261. Clivina Americana Dej. Lawrence.
266. Clivina ferrea Lec. Lawrence.
—. Clivina new species. Topeka.
292. Brachynus alternans Dej. Lawrence.
296. Brachynus fumans Fab., var. similis Lec. Wallace county (Snow).
300. Brachynus stygicornis Say. Western Kansas.
309. Micrixys distinctus Hald. Peabody, from C. P. Arbuthnot.
352. Lebia viridipennis Dej. Topeka and Lawrence.
364. Aphelogenia fuscata Lec. Lawrence (Snow), and West Kansas (Cooper).
386. Axinopalpus biplagiatus Dej. Gove county (Snow).
393. Glycia viridicollis Lec. Lawrence, and Gove county.
448. Platynus pusillus Lec. Lawrence.
461b. Platynus viridis Lec. Topeka.
484. Platynus rubripes Zimm. Lawrence.
501. Platynus sordens Kby. Topeka; rare.
503. Platynus ruficornis Lec. Lawrence.
—. Platynus cinctus. Lawrence.
—. Platynus new species.
563. Evarthrus incisus Lec.
618. Pterostichus scitulus Lec. Western Kansas.
619. Pterostichus lætulus Lec. Lawrence.
626. Pterostichus lucublandus, var. bicolor Lec. Topeka; two specimens; also at Lawrence.
643a. Pterostichus desidiosus Lec. Lawrence.
672. Amara laticollis Lec. Topeka.
693. Amara basilaris Say. Lawrence.
703. Amara convexa Lec. Wallace county (Snow).
709. Amara obesa Say. Western Kansas.
710. Amara diffinis Lec. Wallace county (Snow).
712. Amara chalcea Dej. Western Kansas.
717. Amara gibba Lec. Topeka and Lawrence.
—. Amara fulvipes Putz. Topeka; one specimen; also at Lawrence.
—. Amara cupreolata Putz. Topeka and Lawrence.
726. Badister pulchellus Lec. Lawrence.
729. Badister micans Lec. Lawrence.
748. Dicælus furvus Say. Topeka; a single specimen taken.
794. Chlænius purpuricollis Randall. Lawrence.
796. Atranus pubescens Dej. Topeka; two specimens.
801. Oodes amaroides Dej. Lawrence.
827. Agonoderus partiarius Say. Topeka.
851. Anisodactylus Harrisii Lec. Lawrence.
859. Anisodactylus discoideus Dej. Lawrence.
—. Anisodactylus agricola Say. Topeka; frequent.
913. Selenophorus opalinus Lec. Lawrence.
916. Selenophorus pedicularis Dej. Wallace county (Snow).

921. Selenophorus ellipticus Dej. Lawrence.
942. Harpalus ventralis Lec. Wallace county (Snow).
—. Stenolophus new species. Topeka; one specimen.
975. Stenolophus plebeius, var. fuscatus Dej. Lawrence.
1058. Bemidium perspicuum Lec.
1063. Bembidium striola Lec. Lawrence.
1096. Bembidium variegatum Say.
1099. Bembidium versicolor Lec.
1110. Bembidium affine Say. Topeka and Lawrence.
1127. Tachys proximus Say. Lawrence.
1154. Tachys ferrugineus Dej. Topeka; one specimen.
1158. Tachys nebulosus Chd. Topeka; one specimen.
1188. Hydrovatus cuspidatus Germ. Lawrence.
1201. Hydroporus dissimilis Harris. Lawrence.
1208. Hydroporus patruelis Lec. Lawrence, and Gove county.
1217. Hydroporus lacustris Say. Topeka; abundant where found.
1236. Hydroporus undulatus Say. Gove county (Snow).
1262. Hydroporus concinnus Lec. Topeka; not rare.
1283. Laccophilus 4-lineatus Horn. Gove county (Snow).
1291. Thermonectes ornaticollis Aubé. Western Kansas; also at Lawrence.
1291a. Thermonectes nigrofasciatus Aubé. Topeka.
1322. Rhantus notatus Fab. Lawrence.
1326. Rhantus calidus Fab.
1347. Gaurodytes disintegratus Cr. Lawrence.
1349. Gaurodytes semivittatus Lec.
1356. Gaurodytes obliteratus Lec. Lawrence.
1365. Guarodytes (near) parallelus Lec. Lawrence.
1400. Gyrinus maculiventris Lec.
1402. Gyrinus parcus Say. Western Kansas (Cooper and Snow).
1454. Tropisternus sublævis Lec. Western Kansas (Cooper and Snow).
1465. Berosus miles Lec. Gove county (Snow).
1471. Berosus pantherinus Lec. Lawrence.
1472. Berosus peregrinus Hb.
1489. Philhydrus nebulosus Say.
1493. Philhydrus ochraceus Mels. Topeka and Lawrence; rare.
1494. Philhydrus reflexipennis Zimm (?).
1504. Philhydrus fimbriatus Mels. Gove county (S. W. Williston).
1516. Hydrobius subcupreus Say. Gove county (Snow).
1534. Cercyon prætextum Say. Topeka; not rare, and found under decaying vegetable refuse.
——. Trichopteryx sp. Lawrence.
1710. Tachyporus nanus Er. Lawrence.
1763. Quedius capucinus Grav. Lawrence.
1780. Staphylinus exulans Er. Western Kansas.
1787. Staphylinus cinnamopterus Grav. Lawrence.
1799. Ocypus ater Grav. Lawrence.
1803. Philonthus æneus Rossi. Lawrence.
1821. Philonthus lomatus Er. Topeka and Lawrence.
1834. Philonthus apicalis Say. Lawrence.
1835. Philonthus sobrinus Er. Topeka and Lawrence.
——. Philonthus fusiformis Fauvel Ms. Gove county (Snow).
——. Philonthus sp. Two undescribed species. Lawrence.
——. Xantholinus fusciceps Fauvel. Lawrence.

1880. Lathrobium collare Er. Lawrence.
1881. Lathrobium dimidiatum Say.
1894. Stilicus tristis Mels. Lawrence.
——. Bledius confusus ——. Lawrence.
1991. Oxytelus fuscipennis Mann. Lawrence.
1995. Oxytelus nitidulus (?) Grav. Lawrence.
2001. Apocellus sphæricollis Say. Lawrence.
2012. Anthophagus verticalis Say. Lawrence.
2019. Acidota subcarinata Er. Lawrence.
2046. Omalium repandum Er. Lawrence.
2095. Ctenistes piceus Lec. Topeka.
2100. Tyrus humeralis Aubé. Topeka.
2103. Tychus longipalpus Lec. Topeka.
2124. Bryaxis rubicunda Aubé. Topeka.
2149. Batrisus globosus Lec. Lawrence.
2175. Silpha Carolina L. Wallace county (Snow).
——. Agathidium sp. Gove county (Snow).
2312. Sericoderus flavidus Lec. Lawrence.
2335. Scaphisoma suturale Lec. Topeka.
2336. Scaphisoma terminatum Mels. Topeka.
2340. Toxidium compressum Zimm. Lawrence.
2417. Trogoderma pallipes Ziegl. Lawrence.
2426. Cryptorhopalum hæmorrhoidale Lec. Lawrence.
2441. Mycetina morosa Lec. West Kansas (Cooper).
2468. Litargus sexpunctatus Say. Topeka and Lawrence; frequent.
——. Ceracis sp. Lawrence.
2504. Ceracis Sallei Mell. Topeka; in fungi; common.
2511. Languria læta Lec. Gove county (Snow).
2514. Languria gracilis Newm. Gove county (Snow); Tonganoxie (T. B. Ashton).
——. Atomaria new species. Topeka and Lawrence.
2581. Silvanus bidentatus Fabr. Topeka.
2590. Telephanus velox Hald. Topeka; one specimen.
2599. Læmophlæus fasciatus Mels. Topeka.
2601. Læmophlæus testaceus Fab. Topeka.
2605. Læmophlæus adustus Lec. Topeka.
2666. Bactridium nanum Er. Lawrence.
2688a. Trogosita intermedia Horn. Topeka.
2688b. Trogosita dubia Horn. Lawrence.
2717. Colastus semitectus Say. Topeka; under the bark on freshly cut willow stumps, feeding on the sap.
2719. Colastus truncatus Rand. With the last named.
2725. Carpophilus niger Say. Topeka, and West Kansas.
2731. Carpophilus brachypterus Say. Topeka; very abundant in early spring (1878) on blooming willow catkins.
2743. Epuræa labilis Er. Topeka; three specimens.
2757. Lobiopa undulata Say. Topeka; four specimens, taken in July, on the ground, under decaying fruit.
2813. Olibrus semistriatus Lec.
——. Olibrus ergoti Walsh Ms. Lawrence.
2827. Hippodamia 5-signata Kby.
2867. Psyllobora 20-maculata Say. Topeka and Lawrence.
2871. Exochomus Pilatii Muls. Lawrence.
2877a. Brachyacantha 10-pustulata Mels. Lawrence.

2877d. Brachyacantha albifrons Say. West Kansas.
2897. Hyperaspidius trimaculata L. West Kansas.
2900. Scymnus amabilis. Lec.
2906. Scymnus terminatus Say. Lawrence.
2909. Scymnus Americanus Muls. Lawrence.
2924. Scymnus cervicalis Muls. Gove county (Snow).
——. Scymnus punctatus —. Lawrence.
——. Pentilia sp. Lawrence.
2994. Stenelmis linearis Zimm. Lawrence.
2996. Stenelmis crenatus Say. West Kansas.
2999. Stenelmis vittipennis Zimm. Lawrence.
3013. Heterocerus collaris Kies. Lawrence.
3042. Hister marginicollis Lec. Lawrence.
——. Hister binotatus —. Lawrence.
3062. Hister bimarginatus Linn. Lawrence.
3115. Paromalus seminulum Er.
3158. Saprinus fimbriatus Lec. Wallace county (Snow).
——. Acritus sp. Lawrence.
3198. Aeletes politus Lec. Topeka.
3223. Canthon ebenus Say. Wallace county (Snow).
3248. Onthophagus orpheus —. West Kansas and Lawrence.
3269. Aphodius vittatus Say. West Kansas and Lawrence.
3294. Aphodius terminalis Say. Lawrence.
3338. Ochodæus musculus Say. West Kansas.
3371. Trox scutellaris Say. Lawrence.
3385. Trox erinaceus Lec. Lawrence.
3451. Diazus rudis Lec.
3459a. Diplotaxis frondicola Bl. Lawrence.
3466. Diplotaxis punctipennis Lec. Lawrence.
3468. Diplotaxis Harperi Bl. West Kansas (Cooper).
3475. Diplotaxis morula Lec. West Kansas.
3482. Diplotaxis pacata Lec. Kansas specimens were received from Prof. F. H. Snow.
3484. Diplotaxis Haydeni Lec. West Kansas (Cooper and Snow).
3494. Phyllophaga longitarsis Say. West Kansas (Cooper).
3511. Phyllophaga lugubris Lec. Topeka.
3519. Phyllophaga prunina Lec. Gove county (Snow).
3521. Phyllophaga affinis Lec. Topeka.
3545. Phyllophaga glabricula Lec. Wallace county (Snow).
3614. Aphonus pyriformis Lec. Wallace county (Snow).
3615. Aphonus tridentatus Say. West Kansas.
3654. Cremastochilus saucius Lec. West Kansas (Cooper and Snow).
3689. Dicerca prolongata Lec. Lawrence.
——. Dicerca pruinosa. Lawrence.
——. Chrysobothris new species.
3739. Anthaxia cyanella Gory. Lawrence.
3742. Anthaxia quercata Fab. Lawrence.
3827. Agrilus pubiventris Cr. Gove county (Snow).
3828. Agrilus egenus Gory. Lawrence.
3829. Agrilus lacustris Lec.
3833. Agrilus muticus Lec. West Kansas.
——. Agrilus subvittatus Lec. Lawrence.
——. Agrilus new species near torquatus Lec.
——. Agrilus new species near mancus.

3836. Taphrocerus gracilis Say. West Kansas (Cooper); also at Lawrence.
3845. Pachyscelus laevigatus Say. Topeka; two specimens.
3946. Cardiophorus cardisce Say. Lawrence.
4003. Elater nigricollis Hbst. Lawrence.
4009. Elater Sayi Lec. Lawrence.
4073. Anchastus digitatus Lec. Lawrence.
4154. Melanotus verberans Lec. Gove county (Snow).
4159. Melanotus paganus Cand. Lawrence.
4171. Melanotus sagittarius Lec. Lawrence.
——. Limonius interstitialis —. Topeka.
4230. Athous scapularis Say. Lawrence.
4240. Athous montanus Lec. Lawrence.
——. Asaphes brevicollis —. Lawrence.
4347. Asaphes bilobatus Say. Lawrence.
4400. Prionocyphon discoideus Say. Topeka; rare.
4403. Helodes pulchella Guer. Topeka and Lawrence; rare.
4414. Eucinetus terminalis Lec. Topeka.
4448. Lucidota punctata Lec. Gove county (Snow).
4453. Photinus nigricans Say.
4518. Telephorus dentiger Lec.
4527. Telephorus dichrous Lec.
4559. Silis percomis Say. Topeka.
4561. Ditemnus bidentatus Say. Wallace county (Snow).
4563. Loberus abdominalis Lec. West Kansas.
——. Loberus impressus —. Lawrence.
4589. Collops limbatus Lec. West Kansas.
4612. Anthocomus Erichsoni Lec. Lawrence.
4628. Attalus morulus Lec. Lawrence.
4670. Pristoscelis texanus Lec. West Kansas.
4697. Elasmocerus terminatus Say. Lawrence.
4722. Clerus Spinolæ Lec. Gove county (Snow).
4734. Clerus cordifer Lec. Wallace county (Snow).
——. Clerus n. sp. Gove county (Snow).
4765. Hydnocera tabida Lec. Gove county (Snow).
4769. Phyllobænus dislocatus Say. Lawrence.
4778. Cregya oculata Say. Lawrence.
4789. Corynetes rufipes Fab. West Kansas; common.
4822. Oligomerus obtusus Lec. Lawrence.
4824. Sitodrepa panicea L. Found in great numbers in some grains and seeds received in exchange at the Centennial Exposition by the State Board of Agriculture.
——. Sitodrepa n. sp.
4839. Petalium bistriatum Say.
——. Hemiptychus new species.
4853. Hemiptychus gravis (?) Lec. Lawrence.
4863. Cænocara oculata Say. Topeka and Lawrence; frequent on bushes and plants in the woods on Soldier creek.
4920. Prionus fissicornis Hald. Wallace county (Snow).
5001. Elaphidion rufulum Hald. Lawrence.
5015. Elaphidion unicolor Rand. Lawrence; bred from Red-bud (Cercis Canadensis) by Geo. C. Brackett, Esq.
5025. Tylonotus bimaculatus Hald. Lawrence.
5091. Crossidus pulchellus Lec. West Kansas.

5094. Crossidius discoideus Say. West Kansas.
5104. Cyllene decora Oliv. var. infausta Lec. Gove county (Snow).
5291. Leptura sphæricollis Say. Lawrence.
5310. Monilema semipunctatum Lec. West Kansas; common on Opuntia (Cooper).
5311. Monilema armatum Lec. West Kansas.
——. Sternidius new species. Lawrence.
5394. Eupogonius vestitus Say. Lawrence.
5427. Oberea ruficollis Fab. West Kansas.
5433a. Oberea basalis Lec. Gove county (Snow).
5439. Oberea Schaumii Lec. var. Lawrence.
——. Tetrops sp. Lawrence.
5460. Caryoborus arthriticus Fab. Lawrence.
5465. Bruchus scutellaris Fab. Lawrence.
5478. Bruchus limbatus Horn.
5481. Bruchus pruininus Horn. Gove county, from S. W. Williston.
5496. Bruchus fraterculus Horn. Topeka, and Wallace county.
——. Bruchus n. sp. Lawrence.
5514. Donacia alutacea Lec. Lawrence.
5534. Orsodachna atra Ahr. Topeka and Lawrence; very common in spring in certain localities on the blossoms of wild plum. Var. vittata occurs at Lawrence.
5578. Exema conspersa Mann. Lawrence.
5578a. Exema dispar Lec. Topeka; frequent.
5587. Cryptocephalus sellatus Suffr. Lawrence.
5588. Cryptocephalus lituratus Fab.
5588a. Cryptocephalus lativittis Germ. Topeka.
5589. Cryptocephalus venustus Fab. Topeka and Lawrence.
5595. Cryptocephalus confluens Say. West Kansas.
5609. Cryptocephalus notatus Fab. Lawrence.
5613. Cryptocephalus catarius Suffr. Common on plants in woods in spring; Topeka.
5617. Cryptocephalus chlorizans Suffr. Lawrence.
——. Cryptocephalus new species. With 5613, and very common.
5664. Pachybrachys hepaticus Mels. Topeka and West Kansas.
5666. Fidia murina Cr. Lawrence.
——. Heteraspis new species. Topeka; two specimens.
5674. Heteraspis smaragdula Lec. West Kansas (Cooper).
5693. Chalcoparia globosa Oliv. West Kansas (Cooper and Snow).
5695. Paria aterrima Oliv., var. canella. Lawrence.
——. Chalcophana picipes Oliv. West Kansas (Cooper).
5715a. Colaspis flavida Say, var. lineata. Gove county (Snow).
5730. Chrysomela conjuncta Rog. Wallace county (Snow).
5733. Chrysomela disrupta Rog. Lawrence, and Gove county.
5750. Chrysomela auripennis Say. Lawrence.
5772. Plagiodera oviformis Lec. Gove county (Snow).
——. Adimonia externa Say. Lawrence.
5756. Gastrophysa formosa Say. West Kansas.
5805. Diabrotica blandula Lec. West Kansas (Snow).
——. Diabrotica new species. West Kansas.
5822. Galerucella sagittariae Gyll. Topeka; rare.
5826. Galerucella notata Fab. West Kansas.
5838. Trirhabda nitidicollis Lec. Wallace county (Snow).
5842. Hypolampsis pilosa Ill. Lawrence.

5861. Oedionychis sexmaculata Ill. Topeka; one specimen; also taken at Lawrence.
5871. Disonycha discoidea Fab. Lawrence.
5874. Disonycha collaris F. race mellicollis Say. Lawrence.
5875. Graptodera var. subplicata Lec. Topeka; very common on willows along the Kansas river.
5878. Graptodera ignita Ill. (var.) Topeka and Lawrence.
5881. Graptodera obliterata Lec. Topeka and Lawrence.
5882. Graptodera torquata Lec. West Kansas (Cooper and Williston).
——. Graptodera bimarginata Say.
——. Graptodera new species.
5900. Batophila cerina (?) Lec. Lawrence.
5906. Orchestris bipustulata Fab. Topeka and Lawrence; frequent.
5908. Orchestris Lewisii Cr.
5924. Lyperaltica fuscula Lec. Topeka, on composite flowers; common.
5925. Lyperaltica senilis Say. Topeka; four specimens taken on Actinomeris.
5927. Crepidodera erythropus Mels.
5928. Crepidodera var. violacea Mels. Common in spring on leaves of wild cherry (Prunus).
5928. Crepidodera var. opulenta Lec. Common on leaves of willow.
5930a. Crepidodera mancula Lec. Lawrence.
5931. Crepidodera scabricula Cr. Topeka; one specimen.
——. Crepidodera new species. Lawrence.
5935. Epitrix fuscula Cr. Topeka; common in timber on various plants.
5937. Epitrix near hirtipennis Mels. Lawrence.
5941. Chætocnema subviridis Lec. Topeka and Lawrence.
5947. Chætocnema confinis Cr. Lawrence.
5971. Microrhopala porcata Mels. West Kansas.
5977. Chelymorpha Lewisii Cr. West Kansas.
5980b. Cassida ellipsis Lec. West Kansas (Snow).
——. Cassida sexpunctata —. West Kansas; frequent on Ipomæa leptophylla.
6168. Eleodes fusiformis Lec. West Kansas (Cooper).
6245. Blapstinus vestitus Lec. Wallace county (Snow).
6291. Paratenetus punctatus Sol. Topeka and Lawrence.
——. Paratenetus new species. Topeka.
——. Mycetochares lugubris —. Lawrence.
6390. Isomera quadristriata Cooper. Topeka.
6456. Notoxus apicalis Lec. West Kansas.
6458. Notoxus subtilis Lec. Wallace county (Snow).
6459. Notoxus bifasciatus Lec. Topeka.
——. Notoxus n. sp. Lawrence.
6472. Anthicus elegans Laf. Lawrence.
6479. Anthicus floralis Payk. Topeka; frequent.
6501. Anthicus spretus Lec. Lawrence.
——. Anthicus n. sp. Lawrence.
6527. Xylophilus fasciatus Mels. Lawrence.
6541. Synchroa punctata Newm. Lawrence.
6560. Symphora flavicollis Hald. Topeka; rare.
6561. Symphora rugosa Hald. Lawrence.
6583. Anaspis rufa Say. Gove county (Snow).
6606. Mordella discoidea Mels. Lawrence.

6628. Mordellistena amica Lec. Lawrence.
6648. Mordellistena unicolor Lec. Wallace county and Gove county (Snow).
6662. Mordellistena suturella Helmuth. Gove county (Snow).
——. Mordellistena new species. Wallace county (Snow).
——. Epicauta trichrus var. Gove county (Snow).
6742. Epicauta Stuarti Lec. Wallace county (Snow).
6740. Epicauta lemniscata Fab. Lawrence.
6809. Nemognatha lurida Lec. Wallace county and Gove county (Snow).

Gnathium new species. West Kansas.
Eugnamptus angustatus Hbst. Lawrence.
Rhynchites cyanellus Lec. Lawrence.
Rhynchites aeratus Say. Lawrence.
Rhynchites hirtus Oliv. West Kansas.
Attelabus nigripes Lec. Lawrence.
Epicærus formidolosus Schh. Lawrence.
Eupagoderes sordidus Lec. Lawrence.
Sitones tibialis Germ. Gove county (Snow).
Listronotus squamiger Say. Lawrence.
Listronotus caudatus Say. This species and L. nebulosus occur together on Sagittaria.
Lixus scrobicollis Schh. Lawrence.
Dorytomus brevicollis Lec. Topeka; common on willow.
Dorytomus squamosus Lec. Topeka, and Gove county.
Smicronyx tychoides Lec. Lawrence.
Smicronyx vestitus Lec. Topeka.
Smicronyx squamulatus Lec. Topeka.
Smicronyx new species. Topeka and Lawrence.
Endalus limatulus Lap. Gove county (Snow).
Lissorhoptrus apiculatus Gyll. Lawrence.
Otidocephalus myrmex Hbst. Lawrence.
Otidocephalus Chevrolatii Horn. Topeka; three specimens.
Magdalis pandura Say. Topeka and Lawrence.
Anthonomus fulvus Lec. West Kansas.
Anthonomus rubidus Lec. Topeka.
Anthonomus squamosus Lec. West Kansas.
Anthonomus corvulus Lec. Lawrence.
Anthonomus sycophanta Walsh. Topeka.
Orchestes ephippiatus Say. Topeka and Lawrence; frequent on willow.
Alyca ephippiata Say. Topeka and Lawrence; frequent on willows.
Thysanocnemis fraxini Lec. Lawrence.
Conotrachelus cribricollis Say.
Conotrachelus cratægi Walsh. Lawrence.
Conotrachelus new species. Topeka; one specimen.
Rhyssematus palmacollis Say. Lawrence.
Rhyssematus æqualis —.
Acalles turbidus Lec. West Kansas (Snow).
Acalles carinatus Lec. Lawrence.
Cryptorhynchus obliquefasciatus Boh. Lawrence.
Acamptus rigidus Lec. Lawrence.
Ceutorhynchus decipiens Lec. Gove county (Snow).

Ceutorhynchus new species. West Kansas.
Pelenomus sulcicollis Fahr. Lawrence.
Baris macer (?) Lec. Gove county (Snow).
Baris confinis Lec. Topeka and Lawrence.
Baris transversa Lec. West Kansas.
Baris tumescens Lec. Lawrence.
Baris striata Say.
Baris new species, near carinulata.
Baris pruinosa Lec. West Kansas and Lawrence.
Ampeloglypter Sesostris Lec. Lawrence. Injuries grape vines.
Microcholus new species. Topeka; two specimens.
Barilepton cribricolle Lec. Lawrence.
Barilepton quadricolle —. West Kansas.
Centrinus neglectus Lec. Lawrence.
Centrinus falsus Lec.
Centrinus prolixus —. West Kansas.
Centrinus confusus Boh.
Centrinus modestus Boh.
Sphenophorus ochreus Lec. Lawrence.
Sphenophorus æqualis Gyll.
Sphenophorus melanocephalus Fab.
Sphenophorus pertinax Oliv. Topeka and Lawrence.
Sphenophorus vomerinus Lec., var. baridiodes. West Kansas (Snow).
Sphenophorus placidus Say. Lawrence.
Hypothenemus hispidulus Lec. Topeka.
Hypothenemus distinctus Lec. Lawrence.
Micracis suturalis Lec. Lawrence.
Scolytus quadrispinosus Say. Lawrence.
Hylesinus aculeatus Say. Lawrence.
Eurymycter fasciatus Oliv. Lawrence.
Hormiscus saltator Lec. Topeka and Lawrence.
Anthribus cornutus Say. Lawrence.

A NEW METHOD OF DETERMINING THE WIND'S VELOCITY.

By John H. Long, Class of '77, University of Kansas.

It having been repeatedly stated by certain observers in Kansas that the anemometer of the State University registered a higher than probable velocity, I was induced at the suggestion of two gentlemen connected with the institution, to test the correctness of the instrument. The apparatus used by me was very simple, consisting essentially of a hollow copper sphere suspended in front of a graduated horizontal scale. But as a more detailed description may be necessary to the understanding of what follows, I will give it here. Imagine first a perpendicular shaft of iron, eighteen feet long, whose bottom fits into a socket and to whose top is attached a swivel. To this swivel are fastened several wires whose other extremeties are secured so as to give complete steadiness to the shaft. Other braces are attached for the same purpose, and the swivel on top permits it to turn

METEOROLOGICAL SUMMARY FOR 1877.

Prof. F. H. Snow's Annual Report as Meteorologist to the State Board of Agriculture.

Station: Lawrence, Kansas. Latitude, 38° 57′ 25″; longitude, 95° 15′; elevation of barometer and thermometers, 875 feet above the sea level, and five feet above the ground; rain gauge on the ground; anemometer, 105 feet above the ground, on the dome of the University building, 1,200 feet above the sea level.

The chief characteristics of the weather of 1877 were the large and well-distributed rainfall, the low temperature of the summer months, the high temperature of the winter months, the unusual degree of atmospheric humidity, and the comparative lightness of the winds.

TEMPERATURE.

Mean temperature of the year, 54°.16, which is 1°.33 above the mean of the nine preceding years. The highest temperature was 99°, on the 7th of July; the lowest was 9° below zero, on the 16th of January, giving a yearly range of 108°. Mean temperature at 7 a. m., 48°.54; at 2 p. m., 62°.50; at 9 a. m., 52°.81.

Mean temperature of the winter months, 36°.56, which is 7°.71 above the average winter temperature; of the spring, 52°.81, which is 0°.02 above the average; of the summer, 73°.75, which is 2°.86, below the average; of the autumn, 53°.54, which is 1°.20 above the average.

The coldest month of the year was January, with a mean temperature of 25°.60; the coldeset week was January 7th to 13th, with mean temperature, 17°.49; the coldest day was January 12th, with mean temperature, 3°.2. The mercury fell below zero but three times, all of which were in January.

The warmest month of the year was July, with a mean temperature of 75°.13; the warmest week was July 2d to 8th, with mean temperature 82°.64; the warmest day was July 7th, with mean temperature, 86°. The mercury reached or exceeded 90° on only twenty days, viz; four in June, eight in July, seven in August, and one in September.

The last light frost of spring was on May 1st; the first light frost of autumn was on October 4th, giving an interval of 156 days entirely without frost. The last severe frost of spring was on April 2d; the first severe frost of autumn was on November 5th, giving an interval of fully seven months, or 217 days, without severe frost. No frost or cold weather during the year caused any damage to fruit or fruit buds.

RAIN.

The entire amount of rain, including melted snow, was 41.09 inches, which is 6.71 inches above the average annual amount for the nine preceding years. Either rain or snow fell on 126 days, which is the largest number of rainy days in any year of our record. The longest interval without rain during the growing season, (March 1st to September 15th), was ten days, July 27th to August 6th. The number of thunder showers was thirty-nine, of which two occurred in December.

SNOW.

The entire depth of snow was 15½ inches, of which 8 inches fell in

$$P = z \frac{v_2}{2g} Fy,$$

in which P is the pressure of the wind, z a term dependent on the shape of the body exposed to the wind, $\frac{v_2}{2g}$ the height due to the velocity. v, F the exposed area, y the density of the air. The value of z has been found from experiment to be about 0.64, so transposing the equation to find the value of v_2 we have,

$$v_2 = \frac{2g\ P}{.64\ Fy},$$

from which the numerical value of v can be easily found, as those of g, P, F and z are known. It must be observed that the value of z varies with the barometric height, making it necessary to read the barometer for each set of observations. It is now easy to construct another table, as follows:

For	deflection	of	1	cen.,	velocity	= 3.9	m.	per	h.
"	"	"	2	"	"	5.51	"	"	
"	"	"	3	"	"	6.74	"	"	
"	"	"	4	"	"	7.80	"	"	
*	*		*		*	*		*	*
"	"	"	60	"	"	30.2	"	"	

Finally these values are substituted in the columns of deflections observed, and a mean obtained which represents the wind's velocity for the fifteen minutes of observation.

After making a large number of experiments as above described, I learned these facts regarding the anemometer at the Kansas University: First, that it never registers too much; and second, that for small velocities it does not register enough. This is due to the fact that a gentle wind, whose strength, however, is sufficient to deflect the ball, will fail to move the cups sometimes for many minutes.

The following figures will show results obtained by both methods. The first column contains the velocities determined by the deflected ball, and the second those determined for the same time by the anemometer.

5.6	m. per h.	.64	m. per h.	15.3	m. per h.	15.	m. per h.
10.5	" "	4.84	" "	15.6	" "	14.88	" "
11.68	" "	10.62	" "	17.5	" "	16.	" "
13.5	" "	10.89	" "	18.2	" "	18.15	" "
13.7	" "	12.81	" "	18.7	" "	18.39	" "
14.7	" "	14.5	" "	20.	" "	19.2	" "
15.	" "	14.0	" "	25.3	" "	25.14	" "

It will be observed that for medium and high velocities the two methods compared very well, and for low velocities, as intimated, the anemometer fails to give a large enough record. Besides showing that the apparatus at Lawrence can not register too much, my observations have convinced me that the method is one which may be of value to meteorologists. From its extreme simplicity and lightness, the instrument may be easily carried from place to place by traveling observers, and a record of the wind's velocity at any station can be obtained in a few minutes. As a check upon another instrument it may be used to advantage as just shown. The dimensions which I have given are larger than necessary. I chose them in order to have the copper ball on a level with the cups of the anemometer.

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January, 2 inches in February, 5 inches in March, and half an inch in December. The last snow of spring was on April 3d; the first snow of autumn was on November 8th.

FACE OF THE SKY.

The average cloudiness of the year was 47.12 per cent., which is 2.16 per cent above the average. The number of clear days (less than one-third cloudy) was 162; half-clear days (from one-third to two-thirds cloudy),92; cloudy (more than two-thirds), 111. There were 51 entirely clear and 50 entirely cloudy days. The clearest was August, with an average cloudiness of 29.57 per cent.; the cloudiest month was May, with an average of 62.93 per cent. The mean cloudiness at 7 a. m., was 51.14 per cent.; at 2 p. m., 50.74 per cent.; at 9 p. m., 39.48 per cent.

DIRECTION OF WIND.

During the year, three observations daily, the wind was from the N. W. 278 times; S. W., 259 times; S. E., 184 times; N. E., 148 times; S., 80 times; N., 59 times; E., 38 times; W., 18 times; calm, 31 times. The south winds (including southwest, south and southeast), outnumbered the north winds (including northwest, north and northeast), in the ratio of 523 to 485.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 113,967, which is 33,485 miles less than the average annual distance for the past five years. This gives a mean daily velocity of 312.24 miles, and an average hourly velocity of 13.01 miles. The highest hourly velocity was 55 miles, on March 16th and November 5th; the highest daily velocity was 969 miles on March 8th; the highest monthly velocity was 13,981 miles, in March. The three windiest months were March, April and May; the three calmest months were August, September and October. The average hourly velocity of the wind at 7 a. m., was 11.66 miles; at 2 p. m., 15.55 miles; at 9 p. m., 12.54 miles.

BAROMETER.

Mean height of the barometer, 29.117 inches; mean at 7 a. m., 29.140 inches; at 2 p. m., 29.093 inches; at 9 p. m., 29.120 inches. Maximum, 29.751 inches, on January 22d; minimum, 28.364 inches, on April 18th; yearly range, 1.387 inches. The highest monthly mean was 29.301 inches, in February; the lowest was 28.995 inches, in April. The barometer observations are corrected for temperature and instrumental error.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 72.6; at 7 a. m., 82.12; at 2 p. m., 56.76; at 9 p. m., 79.09. The dampest month was October, with mean humidity, 79.36; the driest month was April, with mean humidity, 64.90. There were eleven fogs during the year. The lowest humidity for any single observation was 22.5, on April 5th.

The following tables give the mean temperature, the extremes of temperature, the velocity of the wind, the percentage of cloudiness, the relative humidity, and the rainfall for each month of the year 1877, and a comparison with preceding years:

YEAR 1877.

Months	Mean Temperature	Maximum Temperature	Minimum Temperature	Miles of Wind	Cloudiness	Relative Humidity	Rainfall in Inches
January	25.60	62.5	—9.0	9,178	48.8	75.5	1.17
February	39.65	66 0	21.0	7 718	47.1	71.8	0.80
March	40.03	81.0	7.0	13,981	54.1	67.2	3.40
April	53.90	81.0	25.0	11,976	53.0	64.9	3.13
May	64.50	85.0	37.0	11,522	62.9	72.0	6.45
June	72.03	95.0	47.0	8,741	38.7	75.3	7.20
July	75.13	99.0	54.0	8,355	32.0	73.4	5.76
August	74.10	97.0	51.5	7,972	29.5	72.0	2.30
September	66.93	90.0	43.0	6,817	33.5	71.7	1.35
October	54.45	80.0	34.0	7,530	58.5	79.4	5.85
November	39.53	64.0	9.0	9,494	48.9	73.8	1.47
December	44.43	68.0	10.0	10,683	58.1	74.4	2.21

COMPARISON WITH PREVIOUS YEARS.

Year 1876	52.76	98.0	— 5.0	148,120	41.27	66.8	44.18
" 1875	50.60	99.0	—16.5	145,316	44.81	65.5	28.87
" 1874	54 20	108.0	— 3.0	145,865	45.54	65.5	28.87
" 1873	52.71	104.0	—26.0	154,508	42.46	64.0	32.94
" 1872	51.90	97.0	—18.0	.....	44.33	64.4	32.63
" 1871	54.30	103.0	— 6.0	.....	48.37	.....	33.23
" 1870	54.50	102.0	—10.0	.....	47.88	68.4	31.38
" 1869	50.99	96.0	— 5.0	.....	49.23	.....	38.51
" 1868	53.36	101.0	—16.5	.....	42.35	.....	37.42

In presenting the above report, I desire to acknowledge my indebtedness to Prof. F. O. Marvin for taking the observations during my six weeks' absence in the summer vacation.

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TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE

FOR

1879-80.

Vol. VII.

Exch.
Kansas Academy of Science
3-13-1934

REPORT.

THE TWELFTH ANNUAL MEETING.

The twelfth annual meeting of the Kansas Academy of Science was held in Topeka, opening on the afternoon of Thursday, November 6th, 1879, and occupying the evening of the 6th and the whole of the 7th.

The lecturers chosen were Prof. B. F. Mudge, who spoke upon the "Mound Builders of North America," and Prof. J. H. Canfield, whose theme was, "The Relation of the State to Higher Education."

The session of Friday, the 7th, was given to the reading and discussion of the papers on the following programme:

Additions to the Catalogue of Kansas Lepidoptera—Prof. F. H. Snow.
List of Kansas Minerals—Prof. B. F. Mudge.
Mounds of Southern Kansas—Joseph Savage.
Recent Additions to the List of Kansas Plants—Prof. J. H. Carruth.
Kansas Meteorites—Prof. G. E. Patrick.
Phonetic Representations of Indian Language—Hon. F. G. Adams.
Notes on Kansas Botany—E. A. Popenoe.
On a Recent Indian Find near Topeka—Dr. A. H. Thompson.
Metamorphic Deposit in Woodson County—Prof. B. F. Mudge.
Impressions of New Mexico—J. C. Cooper.
Entomological Collections Made at Idaho Springs, Colorado, in 1879—Prof. F. H. Snow.
Sink-Holes in Wabaunsee County—Joseph Savage.
Magnesian Limestone in Kansas—Prof. G. E. Patrick.
Elementary Sounds of Language—Prof. J. H. Carruth.
Mound Builders in Davis and Riley Counties—Prof. B. F. Mudge.

The officers elected for the year 1880 were:

President—B. F. Mudge, of Manhattan.
Vice Presidents—J. H. Carruth, of Lawrence; Joseph Savage, of Lawrence.
Secretary—E. A. Popenoe, of Manhattan.
Treasurer—R. J. Brown, of Leavenworth.
The members of commissions of last year were selected for another term.

THE THIRTEENTH ANNUAL MEETING.

The thirteenth annual meeting of the Academy was held at Topeka, November 11th, 12th, and the forenoon of November 13th, 1880.

The popular lecture of the evening of the 11th was delivered by President George T. Fairchild, of the State Agricultural College, whose subject was, "Science in Every-day Life."

The lecture of the following evening was by Prof. J. T. Lovewell, of Washburn College, Topeka, upon "Science in Schools." This lecture was followed by a paper by Col. T. L. Case, of Kansas City, describing the "Ruins of the City of Pécos, New Mexico."

The sessions of Friday, and the forenoon of Saturday, were devoted to the programme given below:

The Fossils of the Judith River Group—Chas. Sternberg.

Description of the North American Species of Conops—Dr. S. W. Williston.

Glacial Scratches—Dr. W. S. Newlon.

Tornadoes of May 30, 1879—Prof. J. D. Parker.

Fragments of Pottery from the Upper Solomon—Prof. D. C. Tillotson.

Artificial Propagation of Food Fishes—Hon. D. B. Long.

Notes on the Botany of Central Kansas—B. B. Smyth.

Douglas County Additions to the List of Kansas Coleoptera—Prof. F. H. Snow.

Preliminary List of the Reptiles of Kansas—Frank W. Cragin.

Traces of the Aborigines in Riley County—Prof. G. H. Failyer.

The Burlington Gravel Beds—Robert Gillham.

Additions to the List of Kansas Lepidoptera—Prof. F. H. Snow.

Memorial of Prof. B. F. Mudge—Prof. J. D. Parker.

Concretionary Forms—Joseph Savage.

Weather Observations in Kansas—Prof. J. T. Lovewell.

The Feldspar Group of Minerals—E. H. Chandler.

The Last New Kansas Bird—Prof. F. H. Snow.

The Igneous Rocks of Kansas—Prof. Robert Hay.

Color-Blindness—Dr. John Fee.

Irrigation—Hon. F. G. Adams.

The Ornithology of Riley County—Dr. C. P. Blachly.

The Rainfall in its Relations to Kansas Farming—H. R. Hilton.

Some New Experiments Lately Exhibited in Boston—Prof. J. T. Lovewell.

Preliminary List of Kansas Hymenoptera—Prof. F. H. Snow.

Stone Implements Found in Trego County—Joseph Savage.

On the Skeleton of an Elephant Found Near Manhattan—Prof. Geo. H. Failyer.

Science Teaching in Common Schools—Hon. F. G. Adams.

A New Form of Pinch-cock—Prof. H. E. Sadler.

Recent Additions to the List of Kansas Plants—Prof. J. H. Carruth.

Mining in New Mexico and Colorado—J. C. Cooper, Esq.

The Coleoptera Collected in Santa Fé Canon, August, 1880, with Descriptions of New Species by Drs. LeConte and Horn—Prof. F. H. Snow.

Officers for the year 1881 were elected as follows:

President—J. T. Lovewell, of Topeka.

Vice Presidents—Joseph Savage and James H. Carruth, of Lawrence.

Secretary—E. A. Popenoe, of Manhattan.
Treasurer—R. J. Brown, of Leavenworth.

The commissions for the ensuing year were filled as follows:

Geology—O. H. St. John, Joseph Savage, and Robert Gillham.

Mineralogy—J. C. Cooper, E. H. Chandler, G. E. Patrick, G. H. Failyer, and George S. Chase.

Chemistry—J. T. Lovewell, G. H. Failyer, H. E. Sadler, G. E. Patrick, and R. J. Brown.

Physics—J. T. Lovewell, L. A. Thomas, and I. D. Graham.

Meteorology—F. H. Snow, J. T. Lovewell, G. H. Failyer, H. R. Hilton, and J. D. Parker.

Astronomy and Mathematics—H. S. S. Smith, J. T. Lovewell, E. Miller, and J. Lee Knight.

Botany—J. H. Carruth, E. N. Plank, and B. B. Smyth.

Zoölogy:

Entomology—E. A. Popenoe, F. H. Snow, and T. B. Ashton.

Ornithology—F. H. Snow, N. S. Goss, and C. P. Blachly.

Ichthyology—D. B. Long and F. H. Snow.

Herpetology—F. W. Cragin, F. H. Snow, and Miss Annie E. Mozley.

Anthropology—F. G. Adams, E. P. West, A. H. Thompson, G. H. Failyer, and J. D. Parker.

Philology—Geo. M. Stearns, D. H. Robinson, and Geo. T. Fairchild.

Board of Curators—J. T. Lovewell, Orestes H. St. John, F. H. Snow, and E. A. Popenoe.

Publication Committee—J. T. Lovewell, J. K. Hudson, and E. A. Popenoe.

RESOLUTIONS.

The committee appointed to prepare suitable resolutions upon the deceased members of the Academy of Science submitted the following:

Whereas, The following members of this Academy have been removed by death since our last annual meeting: Professor Benjamin F. Mudge, of Manhattan, for many years State Geologist, and our honored President at the time of his death; Professor William K. Kedzie, formerly occupying the chair of Chemistry at the State Agricultural College, for several years Chemist to the State Board of Agriculture, and an active member of this Academy, even after his removal to Oberlin College, Ohio; and George P. Cooper, of Topeka, an enthusiastic and promising young entomologist, well known to Eastern specialists as a successful collector of rare Western coleoptera—therefore,

Resolved, That, by the death of these members, the Academy has sustained an irreparable loss.

Resolved, That the sympathy of the members of this Academy is hereby extended to the families of the deceased in their great bereavement.

Resolved, That a copy of these resolutions be entered upon the minutes of this Academy.

(Signed)
F. H. SNOW,
J. D. PARKER,
J. H. CARRUTH.

ADDITIONS TO THE LIBRARY.

There have been received during the time intervening between the report of 1878 and the date of the 1880 meeting, the following:

Psyche—Organ of the Cambridge Entomological Club. Boston. Current numbers to date.

Bulletin of the Torrey Botanical Club. New York. Current numbers to date.

Science Observer. Boston. Numbers to date.

Transactions of the St. Louis Academy of Science. Vol. 4, No. 1.

Transactions of the Connecticut Academy of Arts and Science. Vol. 5, part 1.

Proceedings of the Monthly Meetings of the Entomological Section of the Academy of Natural Sciences. Philadelphia.

Proceedings of the Academy of Natural Sciences. Philadelphia. Vol. —, part 2.

Proceedings of the Boston Natural History Society.

Bulletin of the Essex Institute. Salem. Vol. 2, Nos. 10, 11, and 12.

Bulletin de la Société d'Etudes Scientifiques, de Lyon. Vols. 1, 2, 3 and 4—1874-78.

Bulletin de la Société des Science, Lettres et Arts, de Pau. Vol. 8, series 2.

Comptes Rendus, Société Entomologique de Belgique. Series 2, Nos. 60 to 72, and parts to date for 1880.

Jahresbericht der Naturforschers Vereins Wisconsin, fur 1879-80.

And the following separate pamphlets and papers:

Die Ansiedlungen der Normanen in Island, Grönland, und Nord Amerika, im 9, 10 und 11-jahrhunderts. From the Natural History Society of Wisconsin.

The Heat of the Comstock Lode; and New Methods of Ore Concentration and Gold Amalgamation. By. J. A. Church, E. M., Ph. D. From the author.

PAPERS OF 1880.

MEMORIAL OF PROF. BENJAMIN F. MUDGE.

By John D. Parker, Kansas City, Mo.

Prof. Benjamin Franklin Mudge was born at Orrinton, Maine, Aug. 11, 1817, and died at Manhattan, Kansas, Nov. 21, 1879, in the sixty-second year of his age. When two years old, his father's family moved to Lynn, Mass., which place numbered his ancestors among its first white settlers. His parents were eminent for their piety, charity and hospitality. They encouraged studious habits among their children, providing them with good reading, and stimulating them to literary attainments and knowledge.

Three of Prof. Mudge's older brothers entered the Methodist Episcopal Conference, the oldest of whom died early in his ministry. The second was distinguished as a linguist, particularly in the Greek and Hebrew languages, and the youngest, and only one now living, has an enviable reputation as an author of historical Sunday-school books.

Prof. Mudge graduated at Wesleyan University, Middletown, Connecticut, in 1840, from which institution he received the degree of Master of Arts several years later. During his vacations and at odd moments, he diligently pursued his studies in natural history; and although two years after he graduated he entered the legal profession, yet he never relaxed his interest in science, and for many years the Lynn Natural History rooms contained a large cabinet of his collecting, which was afterward removed to the Kansas Agricultural College, and became the nucleus of the Mudge cabinet.

In childhood he exhibited the same simplicity of life, unselfishness and genuine love of nature, which grew and strengthened with age. Some incidents of his boyhood are illustrative of growing traits of character. When twelve years of age, he went with his three older brothers to hoe in a very weedy corn-field. As usual, the outside row, which the plow had scarcely touched, was much the hardest. A momentary query arose among the brothers who should take this row, when Benjamin said, "I will take that." This was characteristic of his life. In after years he cheerfully remained at the parental home, discharging home duties, though it imposed upon him several years of service at the shoe business longer than his brothers had performed, in order that they might secure the advantages of the higher education, although his thirst for study was developed as early in life and as intense as theirs.

An inquisitive mind with regard to natural objects seems to have been born in him. The features of nature in and about Lynn, the home of his youth, are unusually fine and beautiful. The locality is rich in minerals, and the sea-shore is lined with pebbles, polished by the friction of the waves.

These were the attractive toys of his childhood, and minerals, incrusted moss and sea-shells became the ornaments of the home of his youth. This collection grew by the accumulation of years into that noble cabinet at Manhattan—a monument worthy of any geologist. To sit on some cliff, and watch a stormy sea as it lashed the rock-bound shore, was the joy of his boyhood recreations. Once, after a great tempest, he stood near the edge of a rocky elevation, below which the mighty waves broke, throwing their spray high in the air. He was so much absorbed in the wild scene that he did not observe the spray sometimes shot somewhat above the rock on which he stood. Suddenly, as if angry at his seeming indifference, the sea sent a column of water into the air far above him, which descending, drenched him and his brother from head to foot. Benjamin enjoyed the mishap very much, and spoke of the sea as a friend who could not do him any real harm.

After practicing law for sixteen years, during which he attained a wide reputation for uprightness and fair dealing, and was honored by the mayoralty of Lynn, closing during his administration many saloons, thus creating quite a reform in the liquor traffic, he moved to Cloverport, Kentucky, where he was connected with the Breckinridge Coal and Oil Company.

On the breaking-out of the Rebellion, he removed to Kansas, a State he had been greatly interested in from its beginnings. He located in Wyandotte county, and his natural love for geology soon becoming known, he frequently delivered lectures on his favorite study through the country. In 1864, although a comparative stranger in the State, through the influence of Hon. I. T. Goodnow, the Superintendent of Public Instruction, he was invited to deliver a course of lectures before the Legislature, whereupon that body conferred upon him the office of State Geologist, an honor entirely unsought, yet thoroughly enjoyed. While the State appropriation provided for the office but a short time, he was subsequently elected State Geologist under the State Board of Agriculture, which office he held during life. During all these years he was constantly receiving specimens from all parts of the State, and many a little fortune has been saved to its owner from hazardous ventures for coal, lead or precious metals, by the truthful and always kindly advice from one who knew well how to read "sermons in stones."

In 1865, he was elected to fill the chair of Natural Sciences in the Kansas Agricultural College, to which institution, with a royal munificence, he donated his entire cabinet. It was during one of his summer excursions that he discovered Ichthyornis dispar, a bird with bi-concave vertebræ and teeth —an anomaly to science. In severing his connection with the college, the students were deeply grieved at his departure, and presented him with a valuable watch, which he always carried—an ever-loving reminder of the mutual affection between students and professor.

The last years of his life he spent chiefly in making collections for Prof. Marsh, of Yale College, and thus brought before the scientific world many new and rare discoveries in palæontology.

On Friday evening, Nov. 21, 1879, Prof. Mudge sat at home with his wife, reading the fifth act of Shakespeare's "King Lear"—the wail over the dead Cordelia—when, feeling a pressure in his head, he stepped out of the door to walk in the cool air. A few moments afterward his wife heard a groan, and hastened to his side, but found him unconscious from a stroke

of apoplexy. A physician was hastily summoned, but, by a painless transit, Professor Mudge almost immediately passed to his reward.

On Sunday, November 23d, all Manhattan came to look upon his loved form. Scientific friends from various points of the State and Missouri came to pay warm tributes of praise to the deceased scientist. To his bearers were added four of his scientific friends, Professors Snow, Popenoe and Parker, and Mr. Joseph Savage, all of whom have been intimately associated with Prof. Mudge in his scientific pursuits. The day was beautiful, and the scene, as the immense procession wound its slow and sad way up Cemetery Hill, will not soon be forgotten. And, as the sprigs of evergreen were thrown lovingly into his open grave, we looked forward to the time when he will possess that blessed immortality of which this is a beautiful emblem.

In the summer vacation of 1867, the writer first became personally acquainted with Prof. Mudge. Called to Lincoln College in April of that year, the writer set himself at work to organize a State Scientific Association. For three months he tried to enlist the people of Topeka in such an organization, without the least success. He then wrote to Prof. Mudge, who thought the time had not yet come in the State for such an enterprise. During the summer vacation, the writer, by special invitation, spent three royal weeks with Prof. Mudge, at his home in Manhattan; and during this visit was matured the plan for organizing the Kansas Natural History Society, which afterward grew into the Kansas Academy of Science. Of this organization Prof.Mudge was elected the first President, and was again President at the time of his death. During these twelve years, he was unwearied in his labors, always cherishing plans for the development of the Academy, whose success formed one of the most joyous experiences of his life. His papers are the results of his own observations and experiments, and are real and substantial contributions to knowledge. While Professor at the Kansas Agricultural College, he spent his summer vacations in making collections on the Plains, to enlarge his cabinet—the richest and best in the West; and he would often enrich the private collections of his scientific friends with boxes of specimens. By mutual agreement, Prof. Frank H. Snow, of the State University, and Prof. Mudge had divided scientific work between themselves, in order to accomplish the largest possible results for the new State—the former giving most of his time to living forms, the latter to fossil forms. While at Topeka, at one time, the attention of Prof. Mudge was elicited by seeing impressions on the flagging stones of the sidewalks, and this led to the valuable discovery in science of the so-called bird tracks of the Osage valley. He did much original work in science, and several species which he discovered bear his name.

But Prof. Mudge did not confine his whole attention to scientific pursuits. He was a keen observer of events, and was essentially a man of the people. There was an earnestness and enthusiasm which glimmered in all he said, like sunshine on a beautiful day. All who knew him were charmed with the truthfulness and simplicity of manner which he possessed. He was the most companionable of men, and people everywhere were attracted to him. He was not afraid of the truth, no matter where it might lead him. No road was so rugged he would not follow it in the pursuit of truth. He

would give up the most cherished opinions unhesitatingly, when newly-discovered facts did not sustain them. Still, with all his enthusiasm, he was conservative and prudent, and seldom made mistakes. Those who were intimate with him during our civil war, remember how cheerfully he awaited unfolding events, with a supreme faith in the darkest hours that the right would be triumphant. With him there was no cloud that did not have a silver lining. He manifested the deepest interest in educational progress, and in the growth of the State institutions. He was the life of teachers' associations, and was a favorite lecturer at teachers' institutes. Prof. Mudge was an earnest temperance worker, and a permanent member of many temperance organizations, both in Massachusetts and Kansas. While living at Quindaro, during the war, one of the border towns of Kansas, there was great excitement on the slavery question. Some runaway slaves from Missouri came to Prof. Mudge for work and protection. Their masters offered a large reward for their recovery, and his home and life were threatened in a midnight attack. He would not yield to threats, but protected the refugees, and saved them from being dragged back into slavery.

Prof. Mudge possessed fortitude, or passive courage, which is characteristic of great minds. While living in the West, his sensitive nature suffered many things incident to a formative condition of affairs. But as a pioneer in laying the foundations of society, he moved calmly forward in the discharge of duty, regardless of personal consequences. He possessed great benevolence of being, and always took the most charitable view of human actions. He worked harmoniously with his associates, and as far as possible lived peaceably with all men.

As a teacher, Prof. Mudge was loved and revered by all his pupils. His pleasant and genial manner encouraged the timid, his unfailing knowledge and warm memory served to quicken the ambitious, and his tact and practical insight into personal things developed many a dull scholar to a prominent place in his class. His studies were attractive, and his methods of teaching were characterized by originality. As a teacher, Prof. Mudge was not bookish, although he always prized books for what they are worth. He was truly an original investigator, and nature was the great volume ever placed before him. His love of nature was unbounded, and he seemed to live in the field. His thoughts naturally ran back to his experiences in the field rather than to books, and he drew very largely for his scientific knowledge from original observations. He was the hero of all scientific parties going out from the Agricultural College, and none were considered complete without him as a leader.

In 1871, in speaking of fossil flora, Prof. Mudge mentioned eighteen new species which he had discovered. At another time, a few years later, he spoke of thirty-six new species. On the day of his death he spoke of eighty which he had discovered, and there are probably many more, for he was always very modest in speaking of his own work, while he was ever glad to notice that of others.

Prof. Mudge was the prince of collectors in the West, and possessed all those qualities of body and mind that made him truly successful. As a platform lecturer on scientific subjects, he was a general favorite with all classes. In a graceful and easy manner his ample stores of scientific knowl-

edge would flow forth in rich, spontaneous utterances, and he was able to throw a peculiar charm around the facts of science. The University of Kansas lately honored herself by placing him upon her corps of special lecturers. He was wholly absorbed in his college duties, and was the student's best friend. He opened doors in the temple of science, and inspired his pupils to enter and explore for themselves. As a friend and companion, he was always true and genial. His friendships were remarkably warm and lasting. He was greatly beloved by all his neighbors, and this is a sure test of a good man. He possessed a native purity and refinement of soul, more akin to the refined nature of woman, which never forsook him in his most social hours. He seemed to be born without fear, and his scientific friends relate instances in their western explorations where he would lie down without fear, and sleep till morning, surrounded by hostile Indians. He possessed great simplicity of life, and always felt as if he was a young man. He was always giving public lectures without compensation, and studying methods of conferring favors upon his friends. He feared God and loved righteousness, and those who knew him best believe that he possessed a deep religious nature.

As long as science has a name and place in the great central plains of the North American continent, Prof. Mudge will not be forgotten as a scientific explorer and discoverer.

METAMORPHIC DEPOSIT IN WOODSON COUNTY.

By Prof. B. F. Mudge, A. M.

Much excitement has existed for a year past in Woodson county, Kansas, in relation to the alleged mines of gold and silver at Belmont. These reports induced me, in June, 1879, to visit the spot, in company with Prof. Hay. We found evidence of metamorphic action which I had never before seen in Kansas, except at the lead mines in the subcarboniferous deposits in the southeastern part of Cherokee county. The area under consideration is in the coal measures, and is nearly one mile long and one-third as wide. This lies in sections 29 and 32, town 26, range 15, east. Outside of this small area, the lime shales and sandstones in all directions remain unaltered. Some twenty shafts have been opened in the vain attempt to find valuable ores. These enabled us to abtain a most accurate knowledge of the metamorphic action. I saw no rock which indicated that the changes observed were caused by the direct action of fire. The moderate metamorphism was, in my estimation, clearly caused by the action of warm mineral salicious waters, and probably under-pressure. The change was most marked on the porous sandstones, and less so on the limestones and clay shales. The vapors and hot waters had expelled a portion of the calcareous material of the limestone, and hardened it, by replacing the lost matter with silica. This destroyed the fossils only in part, but gave it a black, basaltic appearance. The clay shales had assumed a more granular appearance, interspersed with

small flakes of mica. We saw over thirty feet of this stratum in several places.

But the most marked metamorphic action was seen in the common sandstone. Its porous character allowed the hot steam and vapor to penetrate freely into all portions of the stratum. At the western portion, near the center of the northwest quarter of section 32, this is seen in blocks of quartzite, about a foot in diameter, and three or four feet long. These lie on the surface, evidently left by the denudation of a portion of the stratum. About a half a mile farther east, where several good-sized shafts are opened, the changes by metamorphic action could be studied in all their details. On the surface were masses of quartz containing clear, glassy crystals, and at one spot quite a number of specimens of beautiful amethyst. This is the first locality of the latter mineral I have found in Kansas.

Here, in a large shaft, about thirty feet deep and nearly as long, can be seen the most varied changes. After penetrating five feet of loose surface material, we have at one edge of the shaft eighteen inches of unaltered red sandstone; below which it is soon altered to a dark-blue chert, and again to pale blue, then cloudy, and finally to a nearly pure white, fine-grained, hard quartzite. In the latter were small spots of carbonate of lime, which could be scratched by the finger-nail. In one side of the shaft, the sandstone assumed the form of bluish-green chert, with small, white spots. This was seen in many of the openings or shafts, and was the rock said to contain the most silver. At a few places the stratum was twisted into small folds, as if the hot water had rendered it plastic, and the pressure had caused it to yield. The colors usually shaded into each other, but sometimes the change was abrupt.

At the deepest shaft, Mr. Van Meter's, the bluish-green chert, or quartzite, is traversed by veins of white quartz, which was said to contain gold; but a portion which I took out did not yield a trace of that metal.

Near the center of the metamorphic area, the strata were dipped as much as 45°. This was undoubtedly caused by the washing out of the underlying stratum, and was very local. At several places we saw sharp, angular fragments of chert, which had become cemented together by the same material. This feature is frequently seen at the lead mines of Cherokee county. In nearly all other respects, the metamorphic action at the two localities are entirely different.

I have caused some of the rock said to yield silver—some specimens given me at the mines, and some that I broke from the ledges and shafts—to be analyzed by Professors Patrick, of the State University, and Failyer, of the State Agricultural College, and no trace of silver, or any metal except iron, was found. I was surprised, when I saw the metamorphic action, not to find any lead, which is usually met with under such circumstances.

I was told at Belmont that assays of rock from these shafts had been made by chemists in Massachusetts and Colorado, and silver had been obtained, varying in amount from $5 per ton to $6.25 per ton. This, it will be seen, is fully equal to the silver mines at Leadville; but, on the other hand, though several thousand dollars have been spent, not a single ounce has been sold as the product of all the mines. This should settle the practical question of the advisability of the enterprise. Whether the ore was "salted"

before it started for Massachusetts, or whether the whole story was a fabrication, I do not know.

I have been thus particular in the description of these mines, because I am constantly consulted on similar wild metallic stories about rich deposits in Kansas, and because the metamorphic action indicated a possibility that silver might be found.

A HOLIDAY EXCURSION TO THE BIRTHPLACE OF MONTEZUMA.

Theo. S. Case, Kansas City, Mo.

Before entering upon a description of the ruins of the Pécos pueblo and church, I will say, that notwithstanding the volumes that have been written by the explorers of this central portion of the western hemisphere, descriptive of its past civilization, the vastness and perfection of that civilization have been by no means comprehended. Every day the hardy and venturesome prospectors of New Mexico, who, like the Spaniards of the sixteenth century, are urged on by an ardent quest of precious metals, discover new evidences of the existence, in prehistoric times, of a race of men, who in architecture, agriculture and the working of gold and silver, possessed a degree of knowledge and skill hardly surpassed in any age. The discoveries of these explorers also go far to prove that the land which is now so unproductive was once sufficiently arable and prolific of vegetation to sustain a dense population, and that the various reasons which are proposed by the writers of the present day to account for the abandonment of the country by these people, such as superstitious fear, the persecutions of hostile tribes, etc., are futile and unacceptable. It seems unquestionable that some vast change took place in the geological and physical condition of the country, causing its fountains to dry up, and changing its fertile valleys into arid wastes, thus literally starving the people out, and forcing them to seek new homes. This idea brings to the front the theory of the continent of Atlantis, with more plausibility than almost any other—a theory which, if established, will enable us to account for the migration of ancient peoples from one continent to the other, without taxing our credulity with the extremely doubtful one of the Behring's straits route. But since this route is buried in the mists of ages, possibly as far back as the Miocene period, when man did not exist, so far as we have been able to discover, we need not discuss it; especially when some of the most learned ethnologists, such as Prof. Retzius and Dr. Daniel Wilson, assert and apparently prove that the brachycephalic race can be traced through the Kurile islands and on the continent, from the latitude of Behring's straits, through Oregon, Mexico and Central America, and the whole length of South America, to Patagonia; also, that the mound-builders of the North were certainly of the same cranial type with the ancient Mexicans and Peruvians. The Abbe Brasseur de Bourbourg, after the ablest and most extensive researches, declares that the pre-Aztec Mexicans or Toltecs were a people identical with the mound-builders;

and Col. J. W. Foster, in his admirable work, the "Prehistoric Races of the United States," says that "They possessed a conformation of skull which would link them to the autocthones of this hemisphere—a conformation which was subsequently represented in the people who developed the ancient civilization of Mexico and Central America."

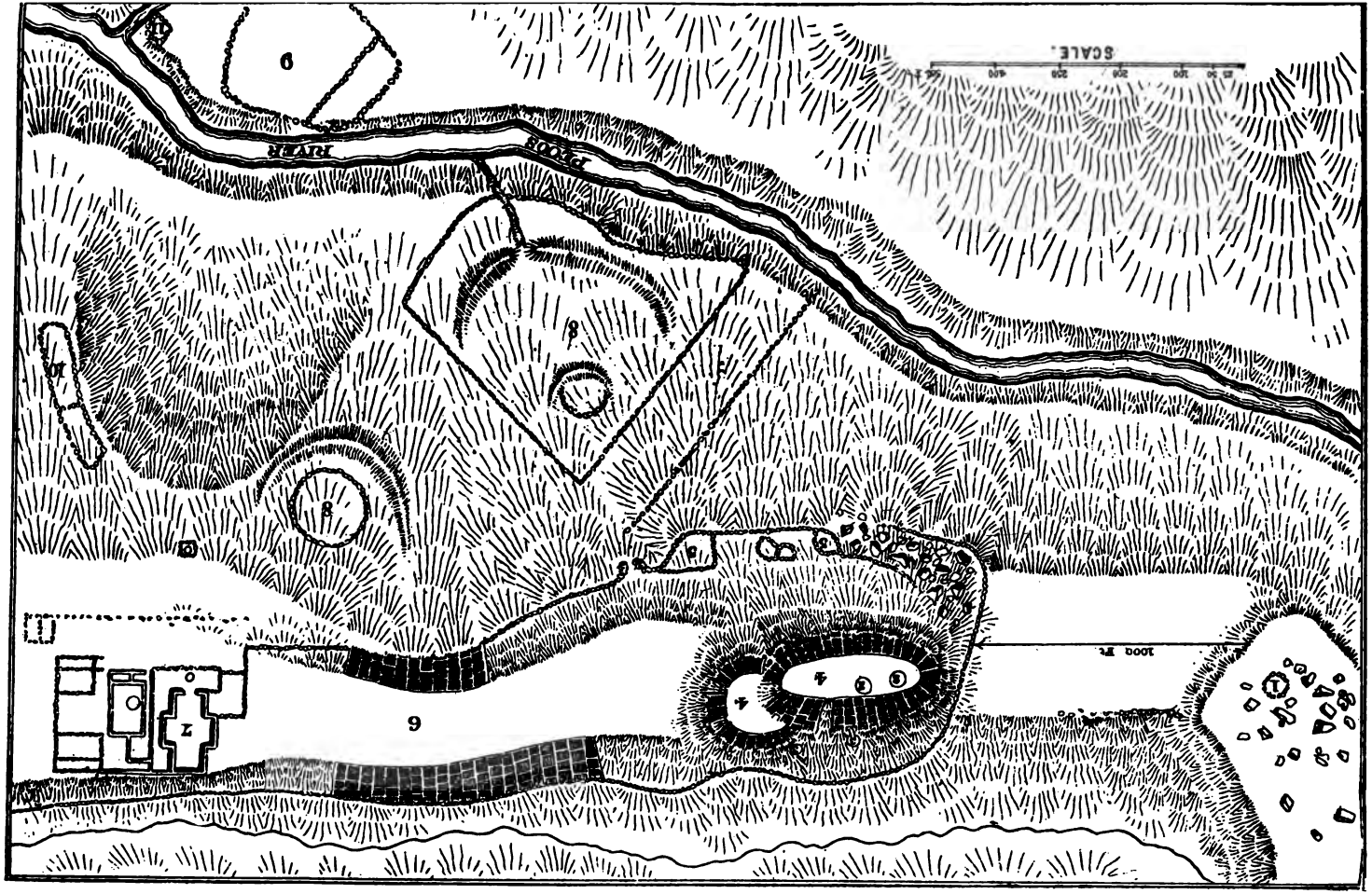
Winchell, in his Preadamites, includes the Pueblo Indians of North America, under the type of Asiatic Americans, and says: "These tribes bear so distinctly an Asiatic stamp as to point to the Mongoloid regions of the Old World as the home of their remote ancestors."

On the other hand, there are not wanting authorities who believe and assert that the civilization of New Mexico is a degraded successor of that of Central America and old Mexico, and that the migration furnishing the tribes that constructed the edifices of New Mexico, was from the South northward, instead of from the North southwardly, in accordance with the traditions of the Aztecs. Among these authorities are Bartlett and Squier, the latter of whom declares that the hypothesis of a migration from Nicaragua and Cuscatlan to Anahuac or Mexico is altogether more consonant with probabilities. Leaving the ethnologists to unravel this mass of contending facts and themes, we will proceed with our narrative.

Arrived at Baughl's station on the Atchison, Topeka & Santa Fé Railroad, which is no more than a siding, where railroad ties are received and handled, and which simply consists of a boarding car and two saloons, we started on foot for the scene of our explorations, about one mile and a half distant.

Before we had proceeded more than half a mile, we came into view of the church and ruins of Pécos, lying on a beautiful plateau on the further side of the Pécos river, separated by a narrow valley from a commanding range of mountains several miles beyond. This plateau seemed to be completely surrounded by mountains; those on the west being grand in their outline, and crowned by a bald peak, which appeared exactly adapted for a watch-tower for the people of the city on the plateau, and perhaps for an outlook for the priests of the sun, who, from its lofty summit, could catch his earliest rays long before they would be visible to the people below. The whole valley, from mountain range to mountain range, is about five or six miles, while it seems to be inclosed at both ends by purple ranges, about ten miles apart, with an occasional snow-capped peak. Thus apparently hemmed in on all sides, and in the midst of what was probably in the day of their prosperity a luxuriant and fertile plain, these ancient people built their singular houses, and lived peaceful and quiet lives. The evidences of their civilization are found in abundance, in implements for grinding corn, pottery evincing various degrees of skill, and in some places in pictured rocks and decorated caves.

These houses are very much alike in all the villages that are known, being built against the sides of bluffs or rocky acclivities, one story above another, to the height sometimes of five or six or seven stories. The material used is stone, cemented together, and sometimes coated or plastered on the outside with mud. The first story has no opening except at the top, which is reached with a ladder, while the other stories have doors opening from the roofs of those below. Within, or at least in the lower or basement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stories, there are connecting openings from one to another. The stories are separated by floors of timbers laid together, and sometimes bound together with withes. Remains of corner-posts, made of pine and cedar poles, are found abundantly in their proper positions.

The system of walls and outworks is very extensive, but whether it is all of the same age as the village, is more than I was able to determine. Commencing at the western end of the plateau, the first evidence of the hand of man that I discovered was a circular stone wall inclosing a space thirty feet in diameter. (1 in plate.) This is located upon a rocky point some 50 feet above the adjacent ground, and commands a view of the valleys on both sides, as well as of the plateau beyond, upon which the village is built. From all indications, this was a fort or lookout tower. (W. H. Holmes, in Bulletin No. 1 of the United States Geological Survey of the Territories, vol. II, 1876, describes the ruins of a tower found in the Mancos canon in Colorado, probably similar to this, whose outer dimensions were forty-five feet in diameter, and twelve feet in height at the highest point of the wall yet standing, which is twenty-one inches in thickness. It was double-walled, with apartments between the outer and inner walls. On the mesa above the bed of the river McElmo, a square-shaped tower was discovered standing on the summit of a great block of sandstone, forty feet high, and detached from the bluff back of it. At another place on the McElmo, the ruins of a triple-walled tower were found, with sectional apartments between the outer and second walls; and such towers abound on prominent points all along the Gila, Chaco, Rio Grande, and other rivers of Colorado and New Mexico.) Proceeding eastwardly, we descend from this point some twenty feet or more to a long and narrow passage of bare rock, not less than 1,000 feet long, by an average width of about 100 feet. On the north side, this passage is defended by a stone wall running along the edge of the rock for a distance of about 300 feet. For the remainder of the distance to the foot of the bluff upon which the ruined village is built, there is no sign of any work done by man.

At the foot of the bluff just mentioned, we come upon the remains of a stone wall, which runs around both sides of the plateau from village to church, being in its whole length not less than 2,000 feet. This wall seems to have been intended for defense, as it is located on the extreme edge of the plateau, all around, just where the steep and almost perpendicular declivity begins.

Commencing here, we are amazed at the size of these ruins. (4.) The buildings were commenced at the foot of the bluff, the rooms of the first story being, say, eight by ten feet, and about seven feet in height. The rooms on this floor have no doors in the side walls, but are entered from the roof, which is reached by a ladder. Upon this story another is built, which is set back from the front of the first, and like it, leans against the side of the bluff. This story has doors in the front of the rooms, which are entered from the roof of the lower story. In this way as many as six or seven stories are built, one upon another, and the buildings are extended laterally as far as the necessities of the community demand, all united as closely together as cells in a honey-comb.

In this Pécos village there were not less than 1,000 rooms, and probably

many more. I could readily count 200 rooms at the top, and from four to six stories on the sides of the bluff. The whole group seemed to consist of two irregular circles, the larger of which extended partially around the end of a rocky bluff, about thirty feet high above the bare rock just described, rising two stories above its summit, and completing the circle or oval upon the surface of the bluff. This circle is 225 feet across in one direction, say east and west, and seventy in the other, with one opening or passage, say sixteen feet wide, leading down the face of the bluff on the northern side, and one into the inclosure on the east.

This area contains two basin-shaped, stone-lined reservoirs, probably for water, twenty-five feet in diameter and more than six feet deep (2), as was proven by digging into them to that depth without finding the bottom of the stone lining. They are filled with earth to within some three or four feet of the surface. Outside of the circle of huts, at the foot of the bluff on the north side, but inside of the stone wall above named, are two similar stone-lined, basin-shaped reservoirs, sixteen feet in diameter, and filled within two or three feet of the surface. (3.) One of these is on each side of the passage-way before mentioned. A very singular thing is, that the western of these reservoirs seems to be connected with one of those inside by an aqueduct or conductor, constructed wholly of cement* made of ashes and some other substance, possibly lime, though no lime or cement of any kind is found in any other part of the works.

This aqueduct is exposed at the margin of the reservoir nearest the bluff, and is at least two feet in diameter, with walls not less than eighteen or twenty inches in thickness. It was constructed by making lumps and blocks of the cement, some rounded and some flat, varying from four to ten inches in diameter, and laying them upon each other like bricks, and fastening them together with layers of similar cement, and finally smoothing the whole over with a coating of the same. I had no implement but an old hatchet, and could do but little in the way of excavating this aqueduct, and may have been mistaken as to its object and purpose; but from its locality and shape, as disclosed by my cutting into it some two feet or more, I think I am correct.

Adjoining the inclosure above described on the east, is a small one, also built around with similar stone huts, two stories high, which is about sixty by seventy feet in diameter, and has two gateways, one to the northeast and the other to the southeast, each ten feet wide and thirty-six feet long. To the southward of both of these inclosures, and close to the rocky declivity, which is bold and commanding, are several remains of walls and buildings, nothing being left but the foundations and some loose rock. The first or western of these is 24x58 feet, the second 24x27, and the third 10x30. Still further east, and on the extreme point of the rock, is a triangular-shaped inclosure 54x69, the third side being made by the wall on the edge of the bluff. From the situation of these (5), especially the last named, they were evidently for the purposes of outlook and defense.

Just east of the huts last described, the ground slopes rapidly to the east and south, with ledges of bare rock making a kind of wall to the southward

*The Mineralogist of the Smithsonian Institution reports that this cement "is composed of silica, carbonate of lime, and carbonate of magnesia, with a trace of iron."

and westward. Still proceeding eastwardly, we pass over some two hundred feet of bare, smooth rock, where we come to two other groups of ruins (6), about four hundred feet in length, one on each side and overhanging the respective bluffs on the north and south sides of the plateau. There are about eighty huts in each of these groups on the summit, making probably about two hundred in all, when averaged at two stories high. They are similar to those just described, being made of stone cemented together with mud, and arranged in rooms of from six to ten feet square. those in the basement story being connected by openings underground. Between these groups of huts the space is nearly or quite two hundred feet wide.

We did not find any rooms among them answering to the description given by several explorers of the estufas, where the sacred fire was kept burning, unless the circular, stone-lined basins, within the court of the larger village, may have been originally covered over and used for such a purpose. (Dr. Hammond, who accompanied Lieutenant Simpson in his United States military reconnoissance in New Mexico, in describing the ruins of Chaco, speaks of sacred estufas, circular in form, excavated several feet deep in the earth, and inclosed with circular wall.) The fact that no water, except perhaps the drippings from the roofs of the upper tier of huts, could naturally find its way into these basins, gives probability to the suggestion that they may have been constructed for estufas, instead of for storing water.

On the south side of the plateau, about half-way between the first and second village, is a gateway in the outer wall, which in that part is six or seven feet high and from three to four feet thick. This gateway is about ten feet wide, and was apparently made to enable the inhabitants to pass out their stock to graze and to water in the inclosures which will be described a little later.

Having now described nearly everything on the plateau that seems to belong to the Aztec civilization, we will pass out of the gate just mentioned, on to the slope that descends gradually to the Pécos river, which winds its way along at a distance of a few hundred yards to the southwardly.

The first thing which attracts our attention is a long stretch of ruined wall, which extends in a southwestwardly direction from a point within about 120 feet from the gate to the bank of the river, 600 feet away. Just beyond the upper end of this wall we find an inclosure (8), walled all the way around, 390 feet by about 120 feet, and banked up with earth at the lower part, as if to retain water. Just at the lower corner there appears to have been an artificial outlet through the dam and wall, for prudential purposes. Within this inclosure is a circular artificial pond, also banked up with earth, about seventy-five feet in diameter. Just east of this inclosure and a little further up the slope is another (8), apparently constructed for the same purpose, being nearly as large, and banked up across the lower part in a similar manner. Within this, also, is a smaller circular pond, 120 feet across, which even at this time was muddy in the center, although it did not contain any water.

Still proceeding eastwardly, there are traces of walls and apparent foundations of buildings all along the slope, and on a little eminence about 200 yards southeastwardly of the inclosure last described, are the remains of two walls (10), inclosing spaces respectively 100 feet square and 125x140.

On the opposite side of the Pécos river, between it and a small stream which empties into it, and 345 feet southeast of the water inclosure first above described, is a kind of pentagonal inclosure, 240 feet in diameter (9), and crossed by another wall which divides it into one large and one very narrow compartment. Just beyond and southeast of this are the remains of what has apparently been a fortification situated just at the confluence of the two streams.

This completes the description of the outside works. We will now return to the plateau. Passing from the groups of Aztec huts last described, we proceed eastwardly 180 feet, and find ourselves face to face with the old Pécos church itself. Before describing this old building (7), we will refer to the history of the discovery of the village, which had its origin long before the Spanish invasion, and which is held by the Aztecs to have been the birth-place of Montezuma himself.

There seems to be no doubt that the Aztecs migrated from some more northern region into Mexico, and the traditions of the present Pueblos, who are believed to be descendants of the original Aztecs, teach that this very spot was the birthplace of Montezuma. But Short, in his "North Americans of Antiquity," claims that this is a different civilization, and that the culture god Montezuma of the Pueblos and the Aztec monarch, Montezuma, are not to be confounded. Dr. Foster, in his "Prehistoric Races of America," does not speak of any such distinction. At all events, all writers agree that Pécos is one of the most important of all the ancient ruins of this region, and that it was one of the sacred cities of the Pueblos. Here the everlasting fire, dedicated to their god Montezuma, was kept burning from time immemorial down to the abandonment of the town, which occurred, according to Short, some time during the second quarter of the present century. Other authorities fix the year at 1837.

One tradition is that Montezuma was born at Acoma, and subsequently removed to Pécos, where he taught the people the arts of civilization, and that when he removed to the south he told them to keep the sacred fire burning until his return. But he never came. Warriors watched the fires, and remained on duty by turns, until through decimation, from one cause and another, the tribe became too much reduced in numbers to keep up the watch any longer. Then three warriors took the remains of the fire and carried it into the mountains, where Montezuma himself appeared and received it. Thus relieved, they abandoned their village, and joined their brothers west of the Rio Grande.

"For generations," as Short eloquently says, "these strange architects and faithful priests waited for the return of their god—looked for him to come with the sun, and descend by the column of smoke which rose from the sacred fire. As of old the Israelitish watcher upon Mt. Sier replied to the inquiry, 'What of the night?' 'The morning cometh,' so the Pueblo sentinel mounts the house-top at Pécos, and gazes wistfully into the east for the golden appearance—for the rapturous vision of his redeemer, for Montezuma's return—and though no ray of light meets his watching eye, his never-failing faith, with cruel deception, replies, 'The morning cometh.' "

In about 1540, Coronado, the Spanish Governor of New Spain, lured by

the resistless rumor of boundless wealth of gold and silver, which no Spaniard could withstand, led an expedition to this very village, then called Cicuyé. The Pécos river must have been a far larger stream than at present, as Coronado found it frozen over with ice strong enough to bear up his horses. He found the settlement of Cicuyé extending along the river for six miles, and the soil extensively cultivated by the Indians. It was from that time that the decline of the tribe commenced. The date of the building of the church is not exactly known,* but it was probably very soon after the invasion by Coronado, for zeal in religious matters was next to lust for gold in the heart of the Castilian, in all of his conquests.

We may imagine that the gentle and tractable Pueblos were speedily induced by their euthusiastic conquerors to embrace Christianity, and that the building of this church was a work of fear of temporal power, rather than of faith in and love of the deity represented by the Spaniards. It was constructed of adobes, which are about sixteen inches long, twelve inches wide, and three inches thick. Its shape is that of the Latin cross, its walls six feet thick, and its dimensions one hundred and forty feet long by forty feet wide, the traverse portion being fifty-seven by thirty-five feet, and its original height about thirty feet. There were several smaller rooms attached on each side, and possibly a building of considerable dimensions on the west side, as there are traces of adobe walls which indicate either a building or an inclosure divided into smaller rooms or lots. I have in my possession a book published in 1854, containing an engraving which represents the church as having a building on the west side. I could find nothing in the appearance of the ground to indicate anything of the kind, either in the way of rubbish or otherwise, and it seems to me, if the church itself could so well withstand the ravages of time, any adjoining building would have endured as well. The roof of the church has been nearly gone for many years, and the side-walls of the front end are also crumbled away nearly to the ground. The rear portion is nearly at its original height, and some of the cross-beams with their rude carvings, remain in situ. The others have been cut away by curiosity-hunters.

The adobes of which the building is constructed are made of a reddish clay, containing small pieces of pottery of a ruder and coarser order than that found about the Pueblo villages. In one of these inclosures, just west of the church, is a small excavation, about twelve feet in diameter, evidently the remains of a water reservoir. Immediately in front of the entrance, and about forty feet from it, is what seems to be an old well, which has been walled up with stone, and has been more recently filled up with earth.

About seventy-five feet still further on, we come to the traces of an old wall terminating on the east in the ruins of several small rooms or inclosures, also of stone. About eighty feet still further, and directly in front of the entrance to the church, is an inclosure about eighteen feet square, with a central stone-heap about three feet square. Still further in the same direction, we find a semi-circle declivity, which was probably originally the work of man, which terminates on the right at the water inclosure described on page 18. In speaking of walls, it is to be remembered that most

*Mr. A. Goselachowski informs me that it was probably erected just about 250 years ago, by the Spanish Jesuits, and that the town and church were destroyed by the Comanche Indians in the latter part of the eighteenth century.

of them are ruins, and many of them mere traces, although readily discernible as one walks over the ground. (7.)

Leaving the church for the present, we will turn back to the ruined villages in search of relics. Broken pottery abounds on all hands, and it seemed to me that I could detect specimens representing at least three distinct periods of time: First, and oldest, that found in the adobes, of which the church is built, which is coarse and rough; second, that which is made of finer clay, but without ornament; and lastly, that which is painted; and perhaps fourthly, that which shows an effort at glazing.

We found numerous flint arrow-heads, all of which were small, none being over one and a half inches in length. Perhaps this is due to the fact that the larger ones have been picked up by earlier explorers. We also found several broken metatas, or grinding pestles; and in one of the large rocks near the upper village, I found three bowl-shaped cavities, about ten inches in diameter, and from three to four inches deep, which I conceived to be the mortars in which the natives ground or beat their corn into meal.

We also found numerous pieces of obsidian, which appeared to have been split off in keen flakes for cutting purposes; also fragments of smoking pipes, with more or less ornamentation cut or scratched upon them. Besides these things, we discovered smaller ornaments, in the way of shells pierced for suspension, pieces of selenite roughly carved into ornamental shapes, and small bits of red paint. Not a scrap of iron, or any kind of metallic weapon, tool or implement could be discovered in either church or village—not even a nail—though it is well known that the natives understood the art of smelting ores—at least those of silver and gold, and of working them most artistically. If other proof of this knowledge were wanting, we could supply it in the form of several pieces of slag picked up near the villages; and the people who reside near say that remains of old smelting works are still to be found in the mountains.

Parts of three days were given to this exploration, in company with Mrs. Case, Major H. Inman, of Kansas, and Mr. A. H. Whitmore, of Las Vegas, all of us being greatly interested, and more than willing to devote much longer time and labor to a more complete examination of these ruins, should another opportunity present itself when we were better prepared to do them justice.

A great many more most interesting things were seen by us in New Mexico, but the limits of this paper have been reached, and an account of the remainder must be postponed until another time, with the closing suggestion, that had these industrious and ingenious natives not been disturbed and driven out by the thriftless and avaricious Spaniards, who never improved any country by their conquest of it, they would in all probability have built up the ruling empire of North America, and thus at least have kept alive the fire of civilization kindled by Montezuma—the culture god—in their minds, until the day of his return, in the millennium.

THE GREAT SPIRIT SPRING.

By Prof. G. E. Patrick, State University, Lawrence.

The "Great Spirit" or "Waconda" spring, situated near Cawker City, Mitchell county, Kansas, is a natural curiosity that has excited much interest among both the savage and civilized inhabitants of the State. From time immemorial, this spring has been held in devout reverence by the Indian tribes that but a few years since hunted over middle and western Kansas; and since the advent of the white man, it has become widely known as an object of wonder and speculation among lovers and students of nature.

The spring is distant from Cawker City about two and one-half miles, in a southeasternly direction; is just within the lower bottom of the Solomon river, being perhaps 300 feet from the first terrace, and about sixty rods from the present bed of the river. It flows, not after the manner of most springs, from some hidden nook or cavern, but from the summit of a nearly symmetrical mound, shaped like a low-statured sugar-loaf—or, to be more mathematical, like a truncated cone. This mound is forty-two feet high, nearly as level on the top as a floor; and in the center of this small tableland is found the spring itself, which is quite as remarkable as are its surroundings. Instead of a gurgling rivulet, trickling away among the rocks, the visitor sees before him a smooth, almost motionless body of water, more than fifty feet across, and filling its basin to overflowing—or if not to actual overflowing, so near it that its surface appears to be upon a level with the top of the mound, and in imminent danger of flowing over at any and all points. The only reason why such overflow does not occur is, that the rock forming the mound is very porous, and affords innumerable minute outlets, just equaling in combined capacity the subterranean inlet.

The dimensions of the mound and basin are as follows, from actual measurement: height of mound, 42 feet; diameter at base, 300 feet; diameter at top, 150 feet. The basin, shaped like a funnel—or better, like an inverted cone—is 35 feet deep at the center; its diameter at top, from "water's edge to water's edge," is, N. to S., 52 feet 4 inches; E. to W., 56 feet 8 inches. These figures show the surface of the pool to be very nearly circular. The limestone stratum inclosing it like a ring, of almost uniform width, makes a fine drive-way for carriages, which find an easy ascent at one especially favorable point.

The reverence with which the Indians have always regarded the "Waconda" spring, is worthy of notice, as exhibiting in a marked degree some mental traits of a race destined soon to pass away. Upon this subject my knowledge is all at second hand, but I am fortunate in having the following statement from one of the earliest settlers of Mitchell county, now a resident of Cawker City, a man whose character vouches for the truth of his words. In response to a request from me, he writes: "In answer will say, that through Indian interpreters I have the statement from various tribes visiting our spring, that Waconda, the daughter of a great Indian chief, at

one time became infatuated with the son of another. The two tribes met at the spring, and being hostile to each other, the intimacy was strongly opposed by the parents, and a conflict ensued. The lover of Waconda, being wounded and weak from loss of blood, fell or was hurled into the pool, whereupon Waconda plunged in after him, and both were drowned. Ever since the spring has been called 'Waconda,' or the 'Great Spirit' spring, and the Indians believe that the spirit of Waconda still dwells in the mound, and sometimes becomes offended at bad Indians, and throws up vast volumes of water, drowning them. The Pottawatomies, who have often been through here on their hunts since this country was settled, could never be prevailed upon to pass the spring without stopping to have a regular powwow, and dip their arrows into its waters. They believed this would give them great success in their hunts and wars with other tribes. Every tribe that has ever visited this country since its earliest settlement, has shown the greatest reverence for the spring, never failing to visit it, and always going through a ceremony over its waters. On one occasion we invited 300 Indians, who were on a buffalo hunt, and were encamped near the spring, to come up to Cawker City and give us a war dance. They accepted, but on no condition would they come until they had been to the spring and daubed their faces and ponies with the gray mud from its banks, and when they came, their appearance in the light of the bonfires built for the occasion was frightful in the extreme."

From the same gentleman, as well as from others, I learn that many relics have been "fished" from the pool, including bows and arrows, a bent rifle or two, arrow-heads, colored stones, medals and beads, (one medal bearing the stamp, "The Fur Company of 1844," and the figures of a white man and an Indian making friends over a pipe of peace,) articles thrown in probably to propitiate the Great Spirit.

It is asserted by many who have made frequent use of the waters of this spring, that they possess valuable medical qualities; and as they have acquired more than a local reputation, I have deemed it worth the while to visit the spring, collect samples of the water, and submit the same to thorough chemical analysis. The following are the results, each figure being the mean of at least two closely-accordant determinations:

Specific gravity at 60° Fah., 1.017.	Grains to U. S. gallon.
Sodium chloride	775.703
Sodium bromide	.234
Sodium sulphate*	206.357
Magnesium sulphate	66.050
Magnesium carbonate	41.023
Calcium carbonate	31.398
Silica (probably combined with soda)	Traces.
Nitrous acid	Minute trace.
Organic matter	None.
Total solids, upon evaporation	1120.765

*In a private report, made some time since, a small amount of the sodium was stated as bicarbonate, and an equivalent amount of magnesium as sulphate. This is probably the more accurate form of statement, as indicated by the CO_2 determination and by the alkalinity after long boiling; but the above is in accordance with the mode of statement now adopted by many chemists, and is in some respects preferable.

Carbonic acid gas evolved upon boiling, 91 cubic inches to the gallon U. S.

From this analysis it is seen that the water of this spring bears a general resemblance to several other waters of the State that have been anaylzed, among them that of the Iola gas well, my report upon which was published in the proceedings of this Academy for 1876—the general resemblance consisting in the presence of a large amount of sodium chloride, considerable quantities of the salts of magnesium or calcium, or both, (besides the carbonates of those metals,) and, usually, some sodium sulphate.

While there is this resemblance, the water of the Great Spirit spring differs from all those hitherto examined, in the great amount of sodium sulphate which it contains. In it the sulphates (of sodium and magnesium) constitute over 24 per cent of the total solids, while in the Iola water they are but a mere trace—little more than .1 per cent. Curiously enough, the two waters (Great Spirit and Iola) contain the same very small amount of bromide (probably of sodium), namely, .234 grain to the gallon. But in respect to iron they differ again, the Iola giving 1.343 grains of ferrous carbonate to the gallond, the Great Spirit containing not a trace.

The most peculiar feature about the spring is the mound, from the top of which it issues. All the reports I have seen—and several have been published in various newspapers—assert that the mound has been built up by the gradual deposition of the saline ingredients of the water; and I visited the spot fully expecting to find a mound composed of sulphates and carbonates of calcium and magnesium, arranged in concentric layers conforming to the outline of the mound, as would be the case had the water of the spring been the architect. But instead of any such arrangement I found the mound to be composed of horizontal strata of limestone, broken off sharply at the edges, where sections of many feet in thickness are exposed. This limestone surprised me by its extreme hardness, which was from four to five, and in some places seemed to me to exceed the latter figure; indeed, so remarkable was it in this respect, that I could hardly believe it to be a mere limestone until I had applied a chemical test. Although it is a limestone, it is not an ordinary one, as is evident from its physical appearance. It is exceedingly porous and unhomogeneous, showing everywhere the results of chemical change effected by some ingredient of the spring-water. That this change has consisted largely in the formation of a hard, insoluble silicate, by metathetical reaction between the sodium silicate of the water and the carbonate of the limestone (or possibly of the water itself), is evident from the physical appearance of the rock. The portions showing the greatest porosity are the hardest, and in the larger cavities a hard layer of silicate can be distinctly seen and easily identified as such.

Although the silica of the water is in so small quantity as to be reported as "traces," I think it perfectly competent to have effected this change, considering the long time it has had for its work. Morevoer, it is the only conceivable agent, under the circumstances.

Being curious to learn what changes, if any, had taken place in the bases of the original limestone, I selected a piece in which silicification had

occurred but moderately, and submitted it to analysis, after having removed by washing all the soluble salts deposited in its pores, with the following result:

Lime, Ca O	52.99	per cent.
Magnesia, Mg O	1.32	per cent.
Ferrous oxide, Fe O	1.07	per cent.
Carbonic oxide, CO_2	42.59	per cent.
Silica, Si O_2	2.03	per cent.
	100.00	

As dilute chlorhydric acid extracts a large part, if not all, of the ferrous salt, and as the hardness of the silicate observed in the rock is greater than that of ordinary hydrated magnesium silicate, I conclude that probably the magnesium and iron are mainly in the form of carbonates, and that the silica is combined chiefly with lime, thus:

Calcium carbonate, Ca CO_3	92.02	per cent.
Magnesium carbonate, Mg CO_3	2.77	per cent.
Ferrous carbonate, Fe CO_3	1.72	per cent.
Calcium silicate, (and silica?)		
Ca O	1.46	per cent.
Si O_2	2.03	per cent.
	100.00	

In this specimen the silification had not been great. I presume specimens could be found showing two or three times as much silicate; and it must be borne in mind that silicate formed in the pores of a limestone by infiltration and double decomposition, would have many times the hardening and cementing power of the same amount of silicate mechanically mixed with the limestone ingredients at the time of deposition—a fact illustrated and applied in the manufacture of the Ransom artificial stone. The small amount of magnesium carbonate hardly indicates metamorphosis, as nearly all limestones contain as much. Indeed, in view of Dr. T. S. Hunt's researches, (Chem. and Geolog. Essays, 2d ed., pp. 138 and 86,) we should not expect a reaction to occur between a limestone and magnesium salts in solution. As the spring water contains no iron whatever, the ferrous carbonate was probably an original constituent of the stone.

The only metamorphosis, then, indicated by this analysis, is that resulting in the formation of three to four per cent of silicate of lime—a small amount comparatively, but sufficient to impart to the stone a hardness plainly superior to that of ordinary limestone.

In conclusion, my explanation for the existence of the mound is, briefly, that the limestone strata constituting the present mound were once continuous across the Solomon valley, and formed the bed of that river; that the Great Spirit spring, then entirely submerged, added its mite upward through the river bottom to the mighty flood above; that the alkaline silicate of the spring water gradually effected the partial silicification of the limestone bed in all directions, within a certain radius, so hardening and

cementing that portion as to enable it to withstand the eroding action of the river, when, having subsided to the limits of the "lower bottom," it disintegrated and washed away the unchanged limestone, leaving the preserved portion (upon the further subsidence of the waters to their present bed) no longer an islet, but a mound upon dry land—a monument to the power of the chemical agencies at work in nature's laboratory.

SINK-HOLES IN WABAUNSEE COUNTY.

By Joseph Savage.

While on a visit to Wabaunsee county during the summer of 1879, my attention was directed to a series of sink-holes which occur near the southern line of the county, some four or five miles northwest of Washara post-office. These sink-holes occupy a space of about four miles in extent from east to west, and a much narrower limit from north to south. They occur upon high prairie, the highest, in fact, in all that region. The surface upon which the sink-holes are situated is quite level, and would make good arable land for cultivation. The sink-holes pass through two rock formations, both of impure limestone. The uppermost formation is about two feet in thickness, while the lower one is four or five feet thick and fifteen or twenty feet below the surface. The sinks pass through both of these strata and the intervening clays, and the subterranean caverns are found below the lower rock formation.

At my request, these sink-holes have been partially explored during the past summer by Mr. S. N. Hills and my brother, Mr. F. Savage. They found the passage-way partially choked up with loose stones, but when fairly down they found a series of caverns of considerable dimensions. The caves were ornamented with numerous stalactites and stalagmites, and one little grotto of columnar structure was so finely scalloped and finished, as to almost if not quite excel in beauty of finish any statuary work of man's device. The apparent beauty of this little grotto was no doubt much enhanced by the dim lantern-light, as well as by the mineral waters constantly dripping over its outer surface. Quite a quantity of loose bones were found in these caverns, showing that they were the frequent habitation of wolves and other wild animals.

The cause of these sink-holes seems to have been in the loose, friable nature of the rock formation which surrounds them, and their surface indications are shown by depressions from forty to eighty feet in diameter; hence, as will be readily seen, the water during heavy rains concentrated and ran into them, causing wet-weather springs along the adjoining drains and ravines.

In a State so richly endowed as we are with thick beds of limestone, one would naturally expect to find numerous sink-holes and openings along our high prairie lands. These openings have been observed in a small way

by the writer in Douglas county, and others of like character are found in Barton county; and it may be presumed that many other counties will contain them, when a more careful scientific survey is instituted.

LIST OF MINERALS FOUND IN KANSAS.

By B. F. Mudge, A. M.

The monotonous geology of Kansas does not allow a great variety in its minerals. The following list includes nearly all found in the State:

1. Alum.
2. Common salt.
3. Glauber's salt, sulphate of soda.
4. Epsom salts.
5. Nitre
6. Copperas.
7. Gypsum, massive.
   - Selenite.
   - Fibrous.
   - Pearl spar.
   - Alabaster.
8. Calcite, or calc spar.
   - Chalk.
   - Oolitic.
   - Satin spar.
   - Stalagmite.
   - Marl.
9. Dolomite or rhomb spar.
   - Magnesian limestone.
10. Iron.
    - Spathic.
    - Pyrites.
    - Oxid.
    - Hematite.
11. Barytes, or heavy spar.
12. Zinc, or blende.
    - Carbonate, or cerussite.
    - Silicate, or calamine.
13. Mica.
14. Feldspar.
15. Hornblende.
16. Spinel, ruby.
17. Manganese.
    - Dendrites, or forest rock.
18. Quartz, flint.
    - Agate.
    - Carnelian.
    - Chalcedony.
    - Jasper.
    - Chert.
    - Amethyst.
19. Silver.
20. Copper.
21. Lead, galena.
22. Zinc, blende, or blackjack.
    - Calamine.
    - Cerussite.
23. Sulphur.

I. Alum is found occasionally in small crystals, in Wabaunsee, Saline, Dickinson, Clay and Republic and some other counties. It is usually associated with gypsum, sulphur, epsom and Glauber's salts, and results from decomposition of shales.

2. Common salt is found in springs and marshes, as can be seen in detail in my article on Geology, in the Kansas Agricultural Report, 1879-80,

page 79. In the southern counties, in the valley of the Cimarron river, it is found in beds, in fine crystals.

3 and 4. Found wherever we have number one.

5. Nitre—Nitrate of Potash. This is the substance (especially when associated with salt and lime) which is called "alkali." It is less common than is usually supposed. We have found it in the western part of the State, but the quantity is not large.

6. Copperas is found in some of the coal seams, attending the decomposition of iron pyrites.

7. Gypsum is found, at least in small quantities, in half the counties of Kansas. The most beautiful cabinet specimens are found in the western portion of the State, in the valleys of the Smoky Hill and Saline rivers. It there presents fine, leaf-like clusters of crystals, sometimes as many as one thousand in a sheet. Single clear crystals are most common in Saline valley, in Ellis county. Pearlspar and alabaster are rare, the latter of poor quality. In southwestern Kansas, in the valley of the Cimarron, fine transparent sheets of selenite are obtained, which sometimes contains a jet black rhombic crystal.

8. Calc Spar, or Carbonate of Lime, is very common in the carboniferous and middle cretaceous deposits, in a great variety of crystals. The finest specimens are found at the lead and zinc mines in Cherokee county. In the carboniferous deposits the crystals are not large, lining small cavities, and not infrequently the inside of fossil shells. In the western part of Riley county is a stratum of calcareous shale which produces geodes. This deposit continues northeast and southwesterly into the adjoining counties. In the Niobrara chalk deposit it forms veins, filling fissures a foot wide and hundreds of feet in length, the center sometimes containing large sheets of crystals accompanied by barytes. These have, by some persons, been taken for quartz veins, although entirely different in elementary composition. Strata of chalk, ten feet in thickness, have been taken from the Niobrara. Oolite is found in Johnson county; satin spar, in Cherokee county and at the Great Spirit spring; stalactite, in the caves at the southeastern part of Cherokee county, with stalagmite.

9. Dolomite, in rhombic crystals, occurs in the subcarboniferous, in Cherokee county. Magnesian limestone, in strata four or five feet thick, in the hills west of Lawrence, and near Fort Scott, but most of the limestone in the State called magnesian is not, but is carbonate of lime.

10. Iron Pyrites is found in almost every part of the State. Spathic iron, hematite and oxid of iron are not uncommon, but in too small quantities to be of market value.

11. Barytes, or Heavy Spar, in fine crystals, is found in Wallace county—the best near Sheridan station; also in Ellis, Nemaha, Ness and Brown counties. The latter is in beautiful flat crystals, of a light pink color.

12. Zinc Blende, with cerussite and calamine, furnishes fine crystals in a variety of forms and colors, from the mines of Cherokee county. Some specimens equal in beauty any from Europe.

13, 14, 15. Mica, Feldspar and Hornblende are not found in situ in

Kansas, and only occur in the drift, and all are in small, inferior specimens.

16. Spinel Ruby was obtained by the writer, in the northern part of Riley county, in a stratum of fine clay shale. The crystals were small and full of fractures, rendering them unfit for jewelry. One was shown me, said to have been found near Milford, which was one-third of an inch across, and of clear, fine grain, which would make a lovely ornament.

17. Manganese, in the form of dendrites or "forest rock," is common from all parts of the limestone deposits.

18. Quartz cannot be considered common in the State, but small crystals are found in every county covered by the carboniferous deposits. They sometimes occur as small geodes, and occasionally line the cavities of fossils. Chert is common in some of the lime strata, and in such cases follow the beds across the State. Agate, carnelian, chalcedony and jasper are found occasionally in the sand-bars of our streams, and belong to our drift deposits. Amethyst in fine crystals is found in the small area covered by the metamorphic rocks of Woodson county.

19. Silver, but in only a few ounces to the ton, has been discovered at the lead mines. It has never been obtained except in such connection.

20. Copper only occurs in very small quantities with iron pyrites.

21,22. For Lead and Zinc, see Geological article, in Agricultural Report.

COLOR-BLINDNESS, AND RAILWAY ACCIDENTS.

By John Fee, M. D.

The visual defect known as Daltonism, or color-blindness, has associated with it two sides—the one theoretical, the other practical. Viewed from a theoretical standpoint, it is connected with the wonderful phenomena of light and its properties, and with the sensitiveness of nerve matter in responding to this imponderable, and, as yet, scarcely understood agent, yet the means of our knowledge of external nature. As a practical topic, it is useful to those unfortunate individuals who, on account of their inability to perceive colors, are unfitted for many avocations, such as painters, artists, or for employment on board of ships, and on railways, in capacities in which they must display and read the language of signals. This practical phase of this subject presents an important question in forensic discussions, when chemists are giving expert testimony, on which depends the life of men charged with crime. No court ought at the present day receive the testimony of any chemist as an expert witness until it has been shown by sworn testimony that he has been tested for color-blindness. In this day of railways, when every one expects to travel, and does almost weekly or monthly use the railway car, the subject of color-blindness becomes of intense interest, and every person has a right to inquire whether this visual irregularity does endanger his safety and his life. I shall there-

fore treat this subject from a double view, viz., theoretical and practical. This subject may be said to be new in this country, and, in fact, it is only within the last decade that it has created any agitation in the scientific world. It is true, the existence of this deformity has been known for nearly a century, but prior to 1794 it had not received the investigation of a scientist. At this time, Dalton, the celebrated English chemist, discovered that he was color-blind, or rather red-blind, and that he did not see the solar spectrum as others saw it. This discovery of Dalton, and his investigations, secured for this irregularity the name of Daltonism, which is the favorite term of the French at the present day for color-blindness.

From Dalton's investigations, in 1794, until 1837, there is scarcely anything written on the subject. It seems to have been almost forgotten. In 1837, Dr. Seebeck, of Berlin, revived the subject of color-blindness, and re-investigated it, and invented tests for determining the frequency and extent of this defect. In 1840, Dr. Isaac Hays, editor of the American Journal of Medical Science, published a paper entitled "The Impossibility of Distinguishing Colors;" and in 1845, Dr. Pliny Earle published in the same journal the report of a singular history of the color-blindness of five generations in his own family. In 1855, George Wilson, Professor of Technology in the University of Edinburgh, published the first practical work on the subject. Wilson's researches were made in view of determining the influence of color-blindness in producing accidents on railways and at sea; and so thoroughly did he discuss this subject, that the Great Northern Railway compelled its employes to furnish satisfactory evidence of the perfection of their color sense. The wide-spread interest on this subject, and its agitation at the present time, are due mainly to the efforts of Prof. F. Holmgren, teacher of physiology in the University of Upsala, Sweden. He treats this subject from all standpoints—historical, theoretical and practical, and gives specific instructions for using colored worsteds for testing the color sense, which is every where known as the Holmgren method. The Professor has tested by his method great numbers of students, soldiers and railroad employes, and gives statistical results. In his native country, such has been the interest which his labors have awakened, that the Swedish Government has caused to be discharged from the railway service all persons found with impaired color sense. His book was quickly translated into the leading tongues of Europe, and into English by the Smithsonian Institution. The number of foreign scientists engaged in the study of this subject are too numerous to be mentioned, and I only insert here the names of Professors Donders, Mauthner, Hering and Helmholtz. This historical outline would be imperfect if I were not to add the name of Prof. B. Joy Jeffries, of Boston, who has written, in addition to numerous essays and reports on this subject, a work entitled "Color Blindness: Its Dangers and Detection." This is the most exhaustive treatise on this visual irregularity in our language; and, besides the experiments and original researches of the author, contains a compilation of most of our knowledge on the subject up to the time of its publication, in the early part of the present year (1880).

What then is color-blindness? Is it the absence of the perception of light? Is it a disease, congenital or acquired? Is it an objective or subjective defect?—an imperfection of the mind, or of its visual apparatus? Color-blindness is not blindness in the ordinary sense of the word. The

visual apparatus is perfect as an optical instrument, and the person has a natural perception of light, and of the form and outline of objects. It is inability to perceive certain colors, usually red and green, and tints of the same; so that the individual cannot distinguish the difference between the color of the leaves of a tree and its fruit. "The color-blind, however, see white and black, and their intermediate and compound, gray, provided they are free from alloy with other colors, precisely as others do."

Again, there are two colors properly so called which they see, namely, yellow and blue, which also if unalloyed they see in the normal manner. But these are the only colors of which they have any sensation, and hence their defect has been called by Sir John Herschel dichromic vision. ("Color-Blindness, Its Dangers and Detection," by B. Joy Jeffries, page 42.)

Here we digress for a moment to state that the evolutionists claim to find in the existence of this defect evidence of their favorite doctrine. According to Geiger and others, what would now be color-blindness was the normal condition of our remote ancestors; the sensibility to colors enjoyed by the present generation is the hereditary rêsult of education prolonged through many generations; in other words, the color sense has been developed by a process of evolution. This theory, developed some years ago by Geiger, who has recently died, has been recently developed at considerable length by Hugo Magnus, Professor of Ophthalmology in the University of Breslau. Magnus divides the colors of the spectrum into three classes: those richest in light, red, orange and yellow; that which has a medium degree of luminosity, green; and those which are feeblest in light, violet, indigo and blue; and argues ingeniously and learnedly to show that the advancing ages acquired each in turn. He maintains that primitive man possessed only the sense of light; that red was the first and violet the last color to be recognized, and that it is not impossible that our descendants may acquire the appreciation of colors that escape the present generation. Geiger stated that the Rig Veda contained no mention of green, blue or violet, and similar statements have been made of the Koran and of the Bible. Magnus says that Xenophon saw only three colors—red, purple and greenish-yellow, in the rainbow, and that the Homeric poems belong to the same color period, as they confound green with yellow. The mention of the Homeric age brings Mr. Gladstone to his feet, who fully adopts the views of Magnus, and shows that Homer perceived red and yellow, but confused green with yellow, and blue with black. ("American Journal of the Medical Sciences," October, 1878, page 474.) We have not time to investigate the Darwinian theory, and pass on.

There are two leading theories in regard to color-blindness, which we shall now examine. The oldest and most popular doctrine is known as the Young-Helmholtz theory, so named after Young, the English physicist, who first taught it, and called Helmholtz, because after it had been forgotten it was rescued from forgetfulness by Prof. Helmholtz, of Berlin. This theory recognizes three base colors—red, green and violet, and consequently three kinds of corresponding elements in the organ of the optic nerve, elements respectively perceiving red, green and violet. "Objective homogeneous light excites these three fibers in varying degree, according to the wave-lengths. The red perceptive fibers will be most strongly stimulated by light of the greatest wave-length, the green perceptive by light of medium wave-

length, and the violet perceptive by light of the shortest wave-length." Prof. Helmholtz is not certain, however, whether there are three kinds of nerve filaments proceeding from the visual cones of the retina, or whether there are three kinds of nerve action in each nerve filament. He says:

"Perhaps there will be much objection to this hypothesis from the number of the necessary nerve fibers or nerve terminations being tripled, in comparison with the common theory in which every individual nerve carries all possible color stimulants. I do not think, however, in this respect, Young's theory is in opposition to any anatomical facts, since we know nothing of the number of transmitting fibers; and then, besides, there are a number of microscopic elements present, the special function of which we do not as yet know. Moreover, this is not the most essential part in Young's hypothesis. That seems to me to be the presenting of color sensations as composed of three wholly independent actions in the nerve substance. It is not absolutely necessary to suppose separate nerve fibers for these separate nerve sensations. The same value of Young's hypothesis in this explanation is shown, if we suppose that in each individual fiber three different and independent actions may take place. Since, however, the form of the hypothesis, as originally proposed by Young, is capable of a more definite presentation and expression than such a modification of it would allow, we will in view of its description retain the original and plainer form. Moreover, the physical phenomena of nerve stimulation, namely, the electro-motor, are not marked in the sensitive nerves and motor nerves by such a variation in action as would necessarily be the case if each nerve fiber transmitted all color sensations. By Young's hypothesis we may apply to the optic nerve the conception of the mechanism of stimulation and conduction which we have derived from the study of the phenomena of the motor nerves. This we could not do, if we must admit that each optic nerve fiber is to have three qualitatively different conditions of stimulation, without mutual interference. Young's hypothesis is only a more special carrying-out of the doctrine of the specific energies of the senses. As the sense of touch and the sense of sight in the eye have evidently separate nerve fibers, so is the same claimed for the sensation of the several base colors. The choice of the base colors is somewhat arbitrary. Any three colors could have been chosen whose combination produces white light. So far as I see, at present, there is no other way of determining the base colors than by the examination of the color-blind." (Jeffries Op. Cit., page 28.)

In support of the Young-Helmholtz theory, its advocates offer these additional physiological facts: "Around the point of best vision, in the center of the retina, is a zone, where we perceive all of the three so-called base colors—red, green and violet. Outside of this is another zone, in which we have a perception of only two colors, namely, green and violet; and again, beyond this, and more externally on the retina, only blue or violet is perceived." The advocates of the Young-Helmholtz hypothesis hold, therefore, to three kinds of color-blindness—red blindness, green blindness and violet blindness. For the present we dismiss the Young-Helmholtz theory, and take up that of Prof. Hering, of Prague. I copy from the American Journal of Medical Sciences Prof. Hering's theory, as stated by Prof. Mauthner:

"According to this theory, vision is produced by the action of light on three separate and distinct chemical substances, which he calls the black-white, the red-green and the blue-yellow. Sight acts on these substances by assimilation and dissimilation. Dissimilation of the black-white substance produces the sensation of white, its assimilation black. As regards the red-green and blue-yellow substances, Hering is undecided as to the D and A colors. But if we take the red and blue as the D colors, the D of the red-green substance would produce red, its A green, and the D of the blue-yellow substance would call forth blue, and its regeneration yellow. All the rays of the solar spectrum act in a dissimilating manner on the black-white substance: that is, they produce the sensation of white, but in different degrees, the yellow acting most powerfully, the others decreasing in power toward the two ends of the spectrum. On the blue-yellow and red-green substances there are certain rays which act in a dissimilating manner, some in an assimilating manner, and some not at all. If the A and D of the black-white substance are of equal intensity, the result is gray. If the A and D of the red-green and blue-yellow substances are equal, the result is negative as to color, and there only remains the dissimilating action of those colors on the black-white substance, that is white. (Amer. Jour. Med. Sci., Oct. 1880, page 532.) According to Hering, therefore, the so-called complementary colors are not complementary, but on the contrary, antagonistic. By their mixture they do not produce white, but being neutralized they allow the white sensation, which they all produce, in a greater or less degree, to come prominently forward. The phenomena of color-blindness, as based on this theory, are as follows: In the achromatrope all the rays of whatever refragibility, acting in a dissimilating manner, white or its shade, gray, is produced. In the dichromatrope, besides the black-white there is only one other substance that can be acted on by the different color rays. If this is the blue-yellow (constituting red-green blindness), the red-yellow and green light act in a dissimilating manner, and the blue in an assimilating manner. The most strongly dissimilating color is yellow; the others are varying—sometimes the red is stronger than the green, and vice versa. To some of the light-waves at the red end of the spectrum, the colored as well as the black-white substance is insensible. In the same way, in case of blue-yellow blindness, where there is only the red-green substance, in addition to the black-white substance, the red-yellow and blue lights act dissimilatingly, and the green assimilatingly. The D color is red, the A color green, and there are certain color rays at the blue end of the spectrum which do not act on either one of the substances. In this case we should have a shortening of the spectrum at the blue end; as in the former case, there would be a shortening of the red end. As an A and D of equal intensity of any one-color substance would result in a total abolition of both colors, so where we have such an action in the case of a dichromatrope, there would be no color perception at all, but only the sensation produced by the action of light on the black-white substance, that is, gray. It is on this account that certain shades of color appear as gray to the dicromatrope. Purple and bluish green are the colors which most dichromatropes confound with gray; but as the dissimilative power of any is not the same in all dichromatropes, we should not expect to find, according to this theory, the same shades of those colors to be invariably confounded with gray. To one, a certain shade would

appear gray, which to another would be blue, and to a third yellow, owing, of course, to the preponderating color after the action of the opposing colors.

"It will be seen, from this point of view, there can be but two forms of color-blindness, according as the one or the other of the color substances is lacking, but as such color substance, by its A or D action, represents two colors, a color-blind individual must be either a dichromatrope or an achromatrope. Hering, therefore, recognizes only red-green blindness, or blue-yellow vision, and blue-yellow blindness and red-green vision, and achromatopsia, or simply the perception of light and darkness." (See Amer. Jour. Med. Sciences, Oct. 1880, page 533.)

To my mind these theories seem ingenious but unsatisfactory. The latter is perhaps more serviceable as a hypothesis. The idea of the existence of separate nerve filaments for the conduction of the different waves of the base colors has no evidence in microscopic anatomy. Once accepted, we shall have a convenient hypothesis for explaining all the qualificative functions of the other cranial nerves. We can hold that the filaments of the olfactory nerves correspond in unlike character, and qualitatively to the different odors that excite them. The same reasoning would be applied to the auditory nerves, and to the gustatory branch of the pneumogastric. As to the different color zones of the retina, we can explain, by saying they are the result of chromatic aberration. The mind perceives the colors where they really are, as the shorter rays first come to a focal point, and then disperse in circular waves over the retina. Further, we know that perception is a mental operation, and is subjective, and not the act of nerve filaments of conducting nerve matter, but is the functional act of the brain cells in which they terminate. Whatever properties there are in objects and light, for the formation of color, must be differentiated by the mind, or that part of it with which the color sense is associated. Late researches show conclusively that the different functions of the mind are associated with different areas of nerve matter, of the cortical substance of the brain, and that the congenital absence of one of these centers, or its destruction by disease, will abolish some functional action of the mind. These areas have been mapped out with considerable certainty as centers of motion and sensation to the various groups of the muscular system; and other important functional areas have also been discovered, such as the speech center. Again, it has long been known that color, light and form have different areas of perception, and that both the perception of light and form can exist independently of the perception of color. The most reasonable hypothesis, or to my mind conclusive explanation of color-blindness, is, that it is a congenital defect, and results from the non-development of the area for the perception of color.

The influence of heredity on mental function has been greatly overlooked. I hold that mental power is both quantitatively and qualitatively more influenced by heredity than by outside influences or education. In a word, I hold that Lock's teachings as to the source of mental power are contradicted by the heredity of genius, the heredity of crime, and all the phenomena of insanity. Color-blindness is, then, a congenital defect, a defect of involution, and consequently cannot be remedied by education. Several French writers have claimed that by systematic efforts the color

sense could be developed in the color-blind, but it is evident from their writings that they have confounded a weak or impaired sense or knowledge of color with color-blindness. Persons who are slow and uncertain in designating color can be educated in chromatics, but the color-blind never. And here permit me to make an observation, in digressing from my subject; it is this: the hardest blow dealt to evolutionists theoretically is, that a qualitative mental function being absent, it cannot be developed by efforts at education; but if a mental characteristic exist, however weak and small, it may always be educated. Hence, it would seem that evolution must always be qualitatively what has first been involuted.

Let us now consider briefly the relation of color-blindness to railway accidents. It is well known that colored signals are absolutely necessary to the management of railways, particularly at night. It has been proposed to substitute form for light, for signals; but the appreciation of light is so much quicker and easier than that of form, that the change has been found impracticable. The ability, therefore, to determine the language of colored signal lights is absolutely necessary to train-men; and consequently, the safety of trains is endangered just in proportion to the number of employes who are defective in the color sense. The extent of this visual deformity can be tolerably accurately determined by statistics. "Dr. Fortenoy found thirty-one color-blind out of 1,084 railroad employes of Denmark, or 2.87 per cent. Prof. Donders, of Utrecht, Holland, found, among 2,300 railroad employes, 152 color-blind. Dr. Stetling, of Cassel, Germany, found, out of 400 railroad employes, six per cent color-blind. Dr. Krohm, in Finland, found, among 1,200 railroad employes, sixty, or five per cent, color-blind. Dr. Holmgren found, among the employes on the railroads in Sweden, 4.8 per cent color-blind." (Jeffries' Op. Cit., p. 143.) From the number of railroad employes tested for the color sense in Europe, and persons examined in this country in the schools, we can assert that there are five per cent of the male population absolutely color-blind, and about five per cent in addition who have an imperfect perception of color. It is also known that the majority of persons who have this defect are unaware of it, or do not know the extent of their deformity. It is apparent, therefore, that this imperfection must be a great factor in the production of collisions and other accidents on rialways. On most railways, red lights signify "danger," white or yellow light, "track clear," and green light, at way-stations, "stop for orders." No person will deny that a certain number of accidents will happen from carelessness and inattention, especially where great numbers of persons are engaged; and if this is so, how can accidents fail to occur among a vast number of persons, of whom five per cent are absolutely incapacitated for discharging the duties assigned to them? That color-blindness is the source of accidents and calamities on railroads, in which property and life are sacrificed, is as apparent as any fact in pure mathematics.

How shall railway accidents and dangers be prevented? Simply by seeing that no men who have this visual defect be employed as train-men; that is, in the capacity of engineer, stoker, brakeman, conductor, or switch-man. This result can be secured by examinations, as first suggested by Wilson in 1855. It is accomplished, according to Prof. Holmgren's method, by having the person to be tested match colored worsteds. For the purpose of making the examinations, colored worsteds are procured, and placed in a pile on a

table or large plane surface. The examinations are made in daylight. "The selection of worsteds includes red orange, yellow, yellow green, pure green, blue; violet, purple pink, brown, gray; several shades of each color, and at least five gradations of each tint, from the deepest to the lightest. Green and gray, several kinds each of pink, blue and violet, and the pale-gray shades of brown, yellow, red and pink, must especially be well represented.* The colors are divided into sample colors, consisting of green, purple and red, and confusion colors, made of every shade and tint of the solar spectrum. The first test consists in matching the sample green color. He who places beside the sample color one of the colors of confusion—that is to say, finds that it resembles the test color—is color-blind. He who, without being quite guilty of this confusion, evinces a manifest disposition to do so, has a feeble chromatic sense. Second test: A purple skein is presented. The color chosen must be between the deepest and lightest shades of the scale. Diagnosis: He who in the second test selects with purple only blue and violet, or one of them, is completely red-blind. He who in the second test selects with purple only green and gray, or one of them, is completely green-blind. Test third: The red skein is presented to the subject. It is necessary to have a vivid red color, like the red flag used as signals on railways. This test, which is applied only to those completely color-blind, should be continued until the person examined has placed beside the specimen all the skeins belonging to this shade, or the greater part, or else, separately, one or several colors of confusion. The red-blind then chooses, besides the red, green and brown shades, which to the normal sense seem darker than red. On the other hand, the green-blind selects opposite shades which appear lighter than red. Violet-blindness will be recognized by a genuine confusion of purple, red and orange, in the second test." (See "Color-Blindness," by F. Holmgren, page 185—Report of Smithsonian Insitution, 1878.)

In conclusion, Mr. President, permit me to say that the principal object I have had in view in preparing this paper has been to interest this Academy in the subject of color-blindness, and through it the Legislature and his Excellency the Governor of the great commonwealth of Kansas. I believe that when this subject is properly presented to the legislators of your State, that some protective legislation can be secured against railroad collisions, so as to render transit on railways less perilous to life. I need not point out to you the numerous so-called accidents and catastrophes that have been chronicled in the United States during the present year. They are not altogether the result of carelessness or criminal negligence, as too often supposed, but result from the visual defect which I have just pointed out. As men of science, I appeal to you who can take a broader view of the subject than the employes of the railways, or even the men whose capital and wealth are invested in these corporations. I know that any legislation on this subject will be characterized as visionary, as yielding to the imagination of impractical men. But our mission is missionary. It is our duty to create, to mould public opinion, and not to vacillate before the scoffs and jeers of those who hold pure progressive science in ridicule. In many places in Europe stringent legislation exists in regard to the employing of the color-

*The word purple here does not designate the color that has that name in this country. It it known to us as Victoria rose, and is said to be carmine diluted with white.

blind by railway corporations. In other countries, the railway corporations have provided the necessary safeguards without the compulsion of legislation. In our country, the National Government has not been slow to appreciate the importance of this subject. By order of the Surgeon General of the navy, all persons connected with the navy have been tested for the color sense, and a record of all defects of this kind are filed with the Department. I presume that Congress will be asked to order the discharge from the navy of every person found color-blind. Hon. John Sherman has issued orders to all inspectors of licenses to have all pilots of steam vessels tested for color-blindness, and to withhold licenses from all persons affected with this defect. In the army all recruits are examined, and all found color-blind are marked unfit for the signal corps.

The agitation of this subject has already commenced in several of our State Legislatures, thanks to the untiring efforts of Dr. Joy Jeffries, of Boston. Massachusetts is deliberating before and discussing the policy of legislation. Connecticut has already passed a stringent and ample law controlling railway corporations in regard to employing the color-blind. Its character may be inferred from the second section of the law, which reads as follows: "Any railroad company or trustee operating any railroad in this State, employing, after the first day of October next, in any of the capacities specified in the second section of this act, any person who does not possess a certificate of freedom from color-blindness, and possession of normal visual power, duly issued in accordance with the provisions of this act, or knowingly employing in any such capacities any person whose certificate has been revoked by the examiners, shall, for each and every offense, be punished by a fine of not less than two hundred dollars nor more than one thousand dollars." Approved March 25, 1880.

Mr. President, I trust the time is not far distant when the agitation of this law will invade this temple of justice and wisdom. From its sacred precincts numberless edicts have gone forth in defense of humanity, which have given the commonwealth of Kansas the proudest position in the sisterhood of the Union. I am happy in believing that there is no subject that concerns the safety of human life, too lowly or insignificant to be introduced here; nor is there any prejudice or vice, or evil or crime, so insolent or contumelious as to intimidate the Goddess of Liberty and Humanity, who has her home within this temple.

THE RAINFALL IN ITS RELATIONS TO KANSAS FARMING.

By H. R. Hilton.

Political economists tell us that the foundation of the wealth and prosperity of a nation lies in the productions of its soil.

Science tells us that the successful production of crops is dependent

principally on the climate, or the proper distribution of heat and moisture.

The climate of a country bears the same relation to its agriculture that the products of the soil do to its general prosperity; and successful farming must rely as fully on a properly-adjusted supply of moisture and heat, as the prosperous State or Nation does on its agricultural production. The farmer may bring drainage, fertilizers and a thorough system of cultivation to his aid; but his success is, after all, proportioned to the kind of season with which he has been favored. That system of farming approaches nearest perfection, that takes into consideration the varieties of climate under which the system is to be carried on, as well as the varieties of soil to be tilled, and engages in the cultivation only of such products as are adapted to both soil and climate.

The resources of Kansas are almost exclusively agricultural, and in Kansas agriculture is specially dependent on the climate. Every business interest in the State is affected, favorably or adversely, as our crop seasons are good or bad; and a thorough and intelligent knowledge of our climate is one that concerns the welfare of our State and every resident in it.

That the system of cultivation and variety of crops in this State should, in so many instances, be so much at variance with the climate and the soil, must be attributed not so much to ignorance on the part of our farmers, as to the fact that both soil and climate were new to them, and different from that to which they had been accustomed in other States further to the East. They had no precedent to follow, and naturally adopted whatever rotation of crops or whatever system of cultivation they had been accustomed to at their former homes. It required, and is still requiring, years of experiment to determine what crops must be abandoned and what adopted, and under what plan of cultivation the best results can be secured. The first ten years of the settlement of any portion of our State may be termed the experimental stage of its history, and many failurs have to be recorded and drawbacks overcome before experiments determine what system of cultivation and variety of crops are best adapted to the wants of that particular section of the State.

In passing over the State from east to west, we find that a gradual change in the soil takes place—that of eastern Kansas being as distinct from the soil of the western counties, as is found in the climate of these respective localities; while in central Kansas we find the soil to be a compromise between the two extremes.

The soil of eastern Kansas is a black loam, resting on a clay formation; that of central Kansas a dark, sandy loam, resting on a porous marl clay formation; while that of western Kansas has a still more sandy surface soil and more porous subsoil. This is the general subdivision, subject to occasional variations. As a rule, the surface soil grows deeper and the subsoil more porous, as we pass from the east towards the west.

The rainfall is graduated from the east to west across the State, with as much regularity as the soil, the precipitation being about one-third greater in eastern Kansas than in western, and about one-fifth greater than in central Kansas. But here a law of compensation enters in to modify this difference, the moisture-absorbing and retaining qualities of the soil being much greater in central and western Kansas than that of the eastern portion of the State. As an illustration of this point, let us take a tract of culti-

vated land with a black-loam surface soil one foot deep, resting on a clayey subsoil. On this tract of land two inches of rain falls. One-half is sufficient to thoroughly saturate the surface soil down to the clay; the balance is rejected for want of capacity in the soil to store it, and in consequence this surplus flows off into the stream.

Let us now take another tract of sandy loam, two feet deep, resting on a porous subsoil, on which two inches of rain falls. This soil, having double the storing capacity of the tract first named, receives all the rain, and instead of wasting half, stores the full amount for future use.

The natural deduction from this would be, that the soil two feet deep, storing a double quantity of moisture, will be more than twice as long in parting with it; not only because it holds more of it, but because it is stored further from the surface and from the influences of the sun's heat, drying winds, and consequent evaporation.

The experience of Eastern farmers who have carefully noted the effects of drainage on their soil is, that a tract of land on which the surface soil has been deepened by drainage will produce crops on one-half the rainfall that was necessary prior to drainage; or in other words, by doubling the capacity of the reservoir for storing and retaining the moisture in the soil, a much less quantity of rainfall is now necessary to produce like results.

It would seem to follow from this, that the amount of rainfall sufficient to raise crops in one locality may be either too much or too little for some other localities having more or less absorptive soil.

For instance, if thirty-five inches be the amount of annual rainfall necessary to farm successfully in the State of Illinois, eastern Kansas, with its better-drained soil, will furnish as much moisture to plant-life on twenty-five inches of rainfall per annum, and western Kansas as much on a fall of twenty inches; and if Illinois and eastern and western Kansas had a like amount of land under cultivation, I think the standard of sufficient rainfall for each would bear about the same relation to each other as the figures I have already quoted, based upon the theory already advanced, that for the purposes of comparison, the absorption and retentive qualities of the soil, and the amount of rain utilized, rather than the amount that falls, shall be taken into consideration. Had time permitted, I should have been pleased to show, by a series of experiments with glass tubes filled with soil, the absorptive qualities of the different varieties to which I have referred, and hope at some future time to have an opportunity to do so. Perhaps some of our State institutions will take this matter up, and give it a more thorough test than it would be possible for me to do.

By keeping in mind the peculiarities of our soil to which I have referred, we can, I think, better understand why cultivation of the soil has so materially changed the climate of our State; and to this subject I wish now to call your attention.

The source of our water supply is mainly in the Gulf of Mexico. This supply is transported hither in the form of aqueous vapor, by means of the great aerial currents that flow northward from the gulf with so little variation during the summer months, and here precipitated in the form of rain. Part of this is received and stored in the soil for the use of plant life, part is returned to the atmosphere by evaporation, and part is drained off into

the streams, and carried back to the ocean, where it is again evaporated and returned to us by the aerial currents. Thus our water supply is making a continual circuit—flowing to the ocean as water, and returning therefrom as vapor.

As the wind currents are the mediums of conveyance of moisture from the ocean to the land, a knowledge of the laws that govern their direction is an important factor in the solution of our probable rain supply.

The summer winds of Kansas are mainly southernly, those from the southeast and south predominating over those from the southwest.

During the winter season, the winds blow from all points of the compass, the prevailing direction being from the west, northwest and north. The summer winds from the south are generally humid. The northerly and westerly winds are generally dry.

The steadiness of the wind breezes from the south during the summer season may be attributed to two causes. One, the trade winds from the northeast, flowing southwest toward the equator, south of the thirtieth parallel, strike against the mountain chain of Central America, and are deflected to the northwest, along the eastern slope of the mountains, and making a grand curve, return over Kansas as a south or southwest wind. The other cause is the monsoon influence of the heat-radiating plains, which attracts the moist and cooler breezes from the ocean. These come to us as south or southeast winds. All of these southerly winds carry more or less moisture.

The same influence that brings to the Mississippi Valley States, parallel with Kansas, their supply of moisture, brings it to Kansas.

Our rainfall is less, simply because we offer less favorable conditions for precipitation. Supply these conditions, and our rainfall is measurably comparable with those States. Where the rainfall of Kansas is deficient, it is more a lack of the necessary conditions of soil, vegetation and local evaporation than a lack of humidity in the aerial currents passing over. The latter are rarely wanting in moisture, during the summer months. The conditions necessary to wring this moisture from the atmosphere are conspicuously absent over a large area of Kansas, and these are: deeply-plowed and well-cultivated fields, growing crops, larger area of trees, ponds of water, and ranker vegetation of all kinds more generally distributed. With these supplied, the question of the sufficiency of our rainfall will not be such a vexatious one as it is at present.

A comparison of the climate of the eastern half of Kansas, before and since it has been brought under man's civilizing influence, affords strong proof of the climatal changes brought about by settlement.

What Kansas is to-day west of the ninety-ninth meridian of longitude, all of Kansas lying west of Topeka was twenty-five years ago. Then the buffalo grass covered all the prairies, except along the streams, as far east as Topeka. Vegetation was scant, as the freighters across the plains in those days can testify. Immense herds of buffalo kept the surface tramped hard, and together with the sun-baking process that it underwent, rendered the soil impervious to rain, which it shed like a shingled roof. Prairie fires aided this petrifying process by burning off the sparse vegetation almost annually. Hot winds were a consequence of this exposed heat-radiat-

ing surface. The principal rain supply of the summer months was through the medium of thunder storms, of great severity. Precipitation took place at a high elevation, and was very rapid. Gentle showers and general rains, such as we are now frequently favored with, were then very rare. During the first ten years farming was attended with many difficulties and discouragements, on account of the seasons, and few believed that the frontier of settlement could ever be extended west of Topeka, except, perhaps, a short distance along the valleys. But in spite of these many discouragements of the climate, the pioneer settlers ventured first just outside the Missouri valley, then gradually westward, step by step, mile by mile, and each year saw a little further advance made upon the Great American Desert, until now we find the land possessed for 300 miles west of the Missouri river. And what has been the consequence of this possession? The plow has been actively at work, and the water-shedding roof on over 8,000,000 acres of land has been torn up; the soil has been tilled, and a storehouse provided for the rainfall that was formerly wasted. Forest and fruit trees, millions in number, have been planted, proving a valuable climate-ameliorating accessory to the cultivated soil and ranker plant growth.

From these combined causes came an increased humidity of the atmosphere, and a more general diffusion of moisture from the new water supply held in reserve. Increased humidity was rapidly followed by plants and grasses that find their best development in a humid climate. The tall blue-stem grass, that could not withstand the dry, arid climate of the plains, now follows in the wake of the settlements, and takes possession of the soil, on which the short, wiry buffalo grass had so long flourished, because it alone was capable of sustaining life on a limited supply of moisture.

The tillage of the soil and growing of trees made the first breach in the arid climate; moisture was sufficiently increased to favor the growth of the blue-stem grasses. When these took possession, I believe their influence was greater than all other causes combined, because by covering the major portion of the country with a heavy coating, that greatly reduced radiation, they removed one of the most stubborn agencies that the pioneer had to contend with. It also, by penetrating the now shaded soil with its strong roots, caused the former surface-hardened roof to leak, and enabled the soil to drink in and retain moisture that had previously been denied it.

Cultivation, tree planting, mulching, change of grasses, prevention of wide-spreading and destructive fires—these are the great agencies that have wrought such a wonderful change in the climate of the eastern half of Kansas. Even if no more rain falls on the earth now than in the early days of the State's history, it is better distributed throughout the season. We have more gentle showers, more general rains, and while we may have as many thunder storms, they are not marked with the severity of the years that preceded the civilization of our soil and climate.

Our streams, that were then constantly fluctuating from dry river-beds to overflowed banks, now have a more even flow, not feeling the effects of heavy showers at once, and overflowing only in cases of extremely heavy rainfall. The moisture held in reserve by the heavy grasses and cultivated soil keeps the streams constantly supplied, and many of these that formerly contained water only a portion of the year, now flow permanently.

We have only to look around us, and note the grasses, the streams, the

soil, products, and the changes in plant growth, to find that nature has furnished us the best possible evidence of the climatal changes that have taken place in our State, and all the statistical data we may compile are valuable only so far as they are corroborated by these evidences which nature presents to us.

Moist air is said to be three-fifths lighter than dry air at the same temperature. Cold dry air possesses greater density and weight than hot dry air.

In the pre-civilized days of Kansas, when vegetation was very sparse, the sun's rays poured down upon the unprotected surface, which, owing to its hardness, absorbed the sun's heat to a very limited extent, and instead threw it off into the surrounding atmosphere, raising its temperature proportionately. The effect of this increased temperature was to set the air in motion. Cooler air rushed in to fill the vacuum, to be again heated and kept in motion.

There being comparatively no moisture in the ground to evaporate and moisten the surrounding air, it remained dry, and being of greater density than the moist currents above, a local stratum of hot air was formed between this moist current and the earth's surface. Being by reason of its greater weight unable to force its way through the lighter air above, its motion became lateral instead of upward; and on account of this lateral motion, the air, in passing over a large area of heated surface, became intensely heated. With the increased temperature came increased velocity, and hence the hot winds so prevalent on the plains many yars ago, and now occasionally experienced on and beyond our frontier of settlements.

After sundown the earth, owing to its limited capacity for absorbing heat, cooled rapidly, and the surrounding atmosphere changed from a hot, dry stratum, to a cold one of greater density, but of diminished thickness.

My theory is, that this stratum of hot, dry air, next the earth's surface, insulates the ground from the moist aerial currents passing over. It is a bad conductor of electricity. Electric communications between the earth and the clouds are difficult to establish, because the earth, by reason of its dryness and lack of vegetation, offers no attraction. When an electric discharge from the clouds to the earth takes place, the resistance of the dry air makes its severity and destructiveness many times greater than would be the case were a good conductor provided; for the better the conductor, the more quietly and harmlessly are these discharges effected.

The atmosphere of the plains is highly electrical, but owing to the insulation referred to, discharges are more frequently made between cloud and cloud, than between the clouds and the earth. When a breach has been made in this insulation, and an electric discharge takes place between clouds and earth, it is generally violent, and followed by rapid condensation and heavy rainfall.

Atmospheric electricity is now believed by many to be a force generated by the liberation of latent heat, when the vapor in the air is precipitated into clouds, or clouds into rain; it is therefore a result, and not a cause, of such precipitation. I believe it, however, to be an important factor in the precipitation of the water held in the clouds, but in what exact way it acts beneficially, we can only surmise.

When the clouds are charged with positive, and the earth with negative electricity, discharges from one to the other invariably follow. The rapidity of the discharge through the air creates a vacuum which sets the air in motion. Its equilibrium has been disturbed, and before readjustment takes place, a portion of the moisture is condensed and parted with in the form of rain.

If I am correct in my theory of the stratification of the atmosphere, it is obvious that, in order to change the climate, we must remove the insulating stratum of dry air, and bring the earth and the moist currents of air more nearly in contact with each other.

We know that eastern Kansas had at one time a climate in many respects similar to that of western Kansas of to-day. We know that the climate of one-half of Kansas has been changed by the civilizing influences of man. Our soil has been surrounded by a new atmosphere. Material for evaporation is now supplied from the reservoirs provided for the reception of the rainfall. The heat imparted to the atmosphere by radiation now carries with it moisture evaporated from the soil; and this warm, humid air, on account of its expansiveness and consequent lightness, rises upwards into higher latitudes, displacing the colder and more dense atmosphere, which sinks to the surface to fill the vacuum created by the uprising current, which is in turn warmed, moistened and carried upward. These ascending and descending currents have a tendency to disturb the relative temperature and consequent equilibrium of the atmosphere. Such conditions favor condensation of the vapor in the air, and the more humid the ascending current the better the electric conductor.

The tendency of thunder storms to follow streams and timber belts may be attributed, I think, not so much to the elevation of the tree itself above the ground, as to the greater amount of humid air that is ascending from such timber belts, affording the most favorable conducting medium. Anything that will aid in increasing evaporation will aid in establishing better communications between the clouds and the earth, and insure a greater frequency of local showers during the summer season.

The mirage, so peculiar to our Western climate, seems to me to furnish excellent testimony regarding the existence of a local stratum of air, and its partial destruction afterward by settlement. The mirage I understand to be due to a ray of light refracted through three or more strata of air of different densities, lifting up into view objects lying below the horizon of our vision. In order, then, to produce the mirage, there must be stratification.

When Reno county was first occupied by settlers, about ten years ago, the buffalo grass covered the prairies, and the mirage could be seen on almost any summer day. Now it is a rare occurrence, because the settlement of the country, and the consequent change of vegetation, have reduced radiation, increased evaporation, and partially prevented stratification.

To increase our rainfall, then, we must do these two things: Reduce radiation and increase evaporation.

Many have an impression that by increasing the local evaporation we really provide the moisture from which we receive the rain. This I think a fallacy. We will undoubtedly get a small percentage of the amount evap-

orated back again in the form of rain, but we must depend mainly on the acqueous vapors brought to us from the Gulf of Mexico for our main supply of rainfall. The local evaporation is valuable to us, because it furnishes the conditions necessary to wring from the atmosphere the moisture we want.

The water supply of timbered countries has been reduced by removing the timber, and again increased by replanting. Yet the annual supply of moisture in the atmosphere was not materially different in the years of a short water supply from those of abundance. The removal of the timber removed one of the essential conditions of rain precipitation, viz.: local evaporation. The replanting of the timber was simply the restoration of the desired condition.

Many of our residents feel discouraged on account of the severity of the drouth on our western frontier during 1879 and part of 1880. Were such drouths of frequent occurrence, it would, indeed, be discouraging, but it must be remembered, that its like was never known in the history of the Plains, and we only find a parallel to it for a shorter period in the drouth of 1860, when the pioneer settlers in this vicinity suffered about all that our frontier settlers have done in the past year. Such an extreme period of drouth we have no reason to anticipate oftener than once in every twenty years, although we are liable to periodic drouths on a smaller scale, the same as any other portion of our country. We must not, therefore, judge of the future by the experience of the past two years; we must take the average of a succession of years.

Within the past few months I have heard the wish often expressed that the western half of the State might be cut off from Kansas, and attached to some other State or Territory, so that we might not be compelled to shoulder the responsibility for the recent failure of crops on our western frontier, and consequently suffer in reputation.

The remark is a foolish one, and the authors will acknowledge it before they are many years older.

The rainfall will, in my opinion, never be so great in western Kansas as in eastern Kansas, but its soil requires less. I do not believe that western Kansas will ever be a general farming country in the sense that eastern Kansas is, but I do believe its natural resources are just as great.

We do not condemn eastern Kansas as a farming or fruit country because bananas and oranges cannot be successfully raised in it; nor do we condemn Florida because the products of a cold climate are not successfully produced there.

Our Western farmers have been experimenting in the past few years, and the stimulating effect of the recent drouth has not been without fruit. New discoveries are being made each season of some new plant more especially adapted to the climate and soil. The rapid development of the Egyptian, or rice corn, in the past two years, is a notable instance of this. The success and value of this new crop, and its ability to stand even as severe a drouth as that of this spring, has been shown beyond a doubt.

The successful and profitable manufacture of sugar from amber cane has been fully demonstrated by Mr. Bennyworth, at Larned, Pawnee county, this season. Mr. Bennyworth has spent about $25,000 in the experiment, and while he failed to establish his works in time to use his cane and make a

financial success, he has accomplished enough to prove that the climate and soil of western Kansas are specially adapted to the raising and ripening of cane. This cane can be successfully raised in the dryest season, and no crop is more certain anywhere. An acre converted into sugar and syrups is estimated to yield from $75 to $100, on a fair yield. There are 10,000,000 acres of land west of the ninety-ninth meridian in this State that will produce $50 worth of sugar per acre, and in the production of it will support a larger population than is possible with any other Kansas crop. Broom corn is a successful crop in western Kansas, and one that, like sugar cane, encourages home manufactures. With a more thorough system of cultivation than that now practiced, wheat will be successfully raised four seasons out of five.

The sheep and cattle interests of western Kansas will always be the most important ones, and the success of millet and rice corn, as feeding crops, in that portion of the State, will stimulate the production of a better grade of beef and mutton than has theretofore come from the west.

With a diversified systef of farming, with each farmer producing a little of each of wheat, sugar cane, broom corn, millet, rice corn, vegetables, etc., and as much stock as they can conveniently handle, instead of confining themselves to one crop, there will be fewer cases of failure to record; but farmers of Kansas, east and west, must remember one thing, that in order to get the most advantage out of their present rain supply, they must plow deep; they must get below the hard upper crust; they must thoroughly pulverize the soil so that it will act as a mulch, and then they will increase the moisture-storing capacity of their soil, and practically make a great increase in the rainfall, by utilizing it to its fullest extent.

A good illustration of the value of such a system of farming, I found recently on the farm of W. H. Gill, of Pawnee county, one of the best cultivated farms in Kansas. In June, 1879, Mr. Gill plowed an eighty-acre field of old ground over eight inches deep, afterwards thoroughly fining the soil by frequent harrowing, and by heavy rolling just before seeding to wheat. After the wheat was again rolled. Both showers did not exceed an inch of rainfall, and yet from that field nine bushels per acre were harvested this year. If such a record can be made under such circumstances, it will be easily seen on what a small rainfall a successful crop of wheat can be raised, when cultivated according to Mr. Gill's method. This instance also illustrates the peculiar properties of this soil for absorbing and holding moisture.

During the first week in October last, rain fell for three consecutive days, almost without cessation, all over western Kansas, and Mr. Gill informs me that not a drop of that three days' rainfall ran off the surface of his plowed land, but all was received into the soil.

The irrigating ditch at Garden City, Sequoyah county, illustrates the same principle. While there last week, I saw fields of corn that would be considered fair in this vicinity, that had only been flooded once this season.

No one questions the fertility of the soil of Kansas, and owing to its fine natural drainage, it is less affected by excessive rains or excessive drouths than the heavy soils of the Mississippi valley States. Our rainy

season is our crop-growing season; our dry season is our stock-feeding season.

Taking our average of the past ten years, our record as an agricultural State is equal to that of any State in the Union. The great diversity of our soil and climate brings within our reach the production of a great diversity of crops; and if we carefully observe and study all its peculiarities, with a view of adapting all our products to it, there is no good reason why Kansas should not be among the leading agricultural States, if not the leading one, of the Union.

ON THE MAGNETIC DECLINATION IN KANSAS FOR OCTOBER, 1880.

By Prof. H. S. S. Smith, State University, Lawrence.

It is required by the law of this State that each county surveyor shall "compare the magnetic with the true meridian at least four times a year, viz., between the first and fifteenth of January, April, July, and October," and shall report "to the Secretary of State, and" to "the President of the University of the State of Kansas." Up to the present year, this law has been, so far as I know, a dead letter. In September last, the President of the University asked me to take charge of the matter, and the results obtained are as follows. It is to be regretted that the discussion is so partial, but the small number of counties heard from—only 36, in a total of 75 organized counties—renders a complete summation impossible. The total number of reports for January is 12; for April, 13; for July, 14; for October, 36.

The following are the figures, arranged in alphabetical order of counties. I give only those for October, as the small number of reports for January, April and July render any conclusions for those months next to worthless:

Town.	County.	Eastern Declination.			Town.	County.	Eastern Declination.		
Garnett	Anderson	10°	30′	E.	Council Grove	Morris	9°	20′	
Great Bend	Barton	10	45	30″	Seneca	Nemaha	10	27	
Concordia	Cloud	10	16		Bazine	Ness	11	30	
Junction City	Davis	10	35		Norton	Norton	11	49	
Lawrence	Douglas	9	30	15	Lyndon	Osage	10	27	
Kinsley	Edwards	11	29	30	Osborne	Osborne	12	20	
Ellsworth	Ellsworth	10	43		Minneapolis	Ottawa	11	22	
Ottawa	Franklin	9	37	30	Phillipsburg	Phillips	11	55	
Eureka	Greenwood	10	10	30	Louisville	Pottawatomie	10	57	
Fordham	Hodgeman	11	45	30	Hutchinson	Reno	10	35	
Burr Oak	Jewell	11	46		Survey	Rooks	11	50	
Oswego	Labette	9	44	30	Lacrosse	Rush	11		
Leavenworth	Leavenworth	9	46		Russell	Russell	11	4	
Mound City	Linn	8	30		Salina	Saline	11	46	20
Peabody	Marion	9	8		St. John	Stafford	11	55	
Marysville	Marshall	11	45		Washington	Washington	10	15	
Paola	Miami	9	35		Fredonia	Wilson	10	30	
Beloit	Mitchell	11	3		Yates Center	Woodson	10	30	

The natural method of treating these observations is to mark on a map the declinations at the several places, interpolate to find points where the declinations are the same, and draw isogonic lines, i. e., lines of equal declination. I have done this on a working map, and the results are far from satisfactory. On the supposition that the reports are all correct, the lines indicate—

1st, That the lines are comparatively regular in the extreme eastern part of the State, and in the western organized counties.

2d, That there is a large area of small declinations, containing the valley of the Kansas as far west as Ellsworth, and extending further from the river to the south than to the north. It contains the part of the Arkansas valley north of that river between Hutchinson and Great Bend, and the valley of the Republican. In Marion and Morris counties the declination is much smaller than in the rest of the area.

3d, The declinations in the valleys of the Saline and Solomon are greater than those in the neighboring portions of the Kansas valley, and correspond approximately to those in the western counties.

4th, The southern parts of the State are not included, as only the eastern counties of the southern rows have reported, and have already been included in the statement concerning the declination in the eastern part of the State.

These results are entirely different from any others of which I have any knowledge. The map showing "the lines of equal magnetic declination in the United States for the year 1875," published by J. E. Hilgard, superintendent of the U. S. Coast Survey, indicates that the isogonic lines in Kansas run regularly, with an average direction of about N. 20° E., and other maps indicate the same. If, then, the reports of the county surveyors are correct, there is here an interesting field for investigation; but the reports are not numerous enough to allow any thorough discussion.

It seems to me, however, that we will get much nearer the truth by making a different supposition, viz.: that the reports are not all correct. Incorrect results can arise from many causes. The following seem to be the most likely to occur:

1st, Imperfect instruments. When a county surveyor uses a shaky instrument, or one whose needle is sluggish and unreliable, I know of no way to remedy the defect, other than by getting a good instrument. If constant errors are suspected, comparison with a good needle might do away with the difficulty.

2d, Carelessness. By carelessness, I do not mean hasty and poor work. Of such a charge each one should be considered innocent until proved guilty. But I do mean the neglecting to humor the needle, to let it swing freely in the box before coming to rest, and to protect it from accidental local attraction. An ax or chain inadvertently left near the instrument, or a pair of steel-rimmed spectacles worn during the observation, will sometimes cause errors amounting to two degrees.

3d, Defective meridian marks. This is probably the most frequent and troublesome cause of error. As a rule, county surveyors are not supposed to be adepts in astronomical operations, and the determination of a true meridian at any point is based on essentially astronomical observations. To

do it well, the observer must not only have the knowledge, but must also be provided with suitable instruments—a good time-keeper, and a transit instrument so arranged that the cross-hairs can be made visible at night. A solar compass is a good instrument for the purpose, but is not generally considered as reliable as a portable astronomical transit.

I have no doubt that some way can be devised by which a competent person could be engaged to set up correct and permanent meridian marks at each county seat. At present, I do not know just how such an arrangement can be made. Until some such step is taken, these reports, required by law, and, if well taken, of great use to the landed interests of the State, and of value in the scientific discussion of magnetic phenomena, will remain of comparatively little importance.

BOTANICAL NOTES FROM THE SOUTHWEST.

By B. B. Smyth.

The studies herein contained were made in Barton and other counties of southwestern Kansas, along the line of the Santa Fé Railroad, from 1874 to 1880.

During the spring months, there is no place more beautiful or interesting to the passer-by or the botanist than the prairies of the southwest. The abundance, beauty and size of many of the flowers causes cerain spots to rival some of the showy Eastern flower gardens. A study of these plants and flowers is not without attending difficulties. Very many of the plants are different from those growing east of the Mississippi, and are not described in the Botanies of Wood or Gray. A Synopsis of the Flora of Colorado, by Porter & Coulter, contains many plants of western Kansas; though there are still others of which descriptions are not readily attainable. I am under obligations to Prof. J. H. Carruth, of Lawrence, State Botanist, also to Prof. Wood, of New York, for the determination of many plants of which no description is at hand.

In March, there are two plants, besides a little carex three inches high, that open their blossoms, sometimes partly under the snow. One is a little wild parsnip, three inches high, with umbels of very small, white, fragrant flowers. It is said to be Peucedanum nudicaule, though the plant differs from the description in the following respects: the name nudicaule indicates a naked stem, while the plant is well covered with leaves half-way up the stem, and that portion of the stem below the ground—three inches of it—is entirely sheathed with radical scales and leaves. Then the leaves, instead of being bipinnate or ternate-pinnate, are bipinnately or terpinnately divided—the segments pinnatifid or bipinnatifid. Occasionally the seeds are

greatly inflated, becoming nearly half as thick as wide. An examination discloses a small, dark-colored coleopterous insect, seen nowhere else. In early seasons, the plant blossoms as early as February. The other is also a small umbelliferous plant, Cymopterus montanus, three inches high, blossoming toward the close of the month. It may be distinguished from the Peucedanum by its vernicose leaves, and its seeds with five or six vertical wings each, while the Peucedanum has but two.

Astragali are quite numerous and abundant; all blossom in April and May. Among the first is Astragalus caryocarpus, commonly called "buffalo pea." The blossoms vary on different plants, through all shades, from a pale straw-color to a rich crimson. They all change to yellowish in fading. The fruit is somewhat edible when young and tender. It is occasionally used as a substitute for green peas or asparagus. It is said by frontiersmen to possess powerful pectoral properties, clearing the throat and making the breath flow freer. The fruit, when ripe, resembles, in color, shape and size, a shell-bark hickory-nut, but is very light and corky.

A similar plant, blossoming at the same time, is A. Mexicanus. The color of blossom is about the same, with nearly the same variations. The habit and general appearance of plant and leaf are also much the same, and the plants are very apt to be confounded in the herbarium. An intimate acquaintance shows recognizable differences. In the latter, the stems, at the base, are smaller, harder and darker, and are more prone to cast root at the joints. The leaflets are a little more slender, and the pubescence, (what little there is,) is sparser and more closely appressed. But the fruit, when ripe, differs greatly. The pods are much smaller, harder, have a deeply sulcate ventral suture, and a hard, sharp, afflexed point.

Another astragalus that is quite showy is A. mollissimus. The flowers, a purplish straw color, are not showy, though the plant is quite so in the winter, with its large, green, very wooly leaves. I am informed by Prof. Popenoe that this is the "loco" plant, said to be poisonous to stock, though I believe they do not generally eat it.

A plant that is apt to be mistaken for an astragalus is Oxytropis Lambertii. It grows very abundantly on dry hillsides, each plant sending up numerous tall, loose racemes of crimson flowers. A hill covered with these looks like an immense floral mound.

There is a sort of dandelion (Troximon cuspidatum), with long, wavy-edged leaves. The flowers resemble the old-fashioned dandelion in many respects, and, like that, close in the evening and damp weather.

Abundantly, in some spots on the prairie, we find the wild onion (Allium reticulatum), with its pretty clusters of pink, star-shaped flowers, six inches high. The flowers have the odor of, and much resemble, garden pinks, though care in handling is necessary, so as not to crush the plants, or the odor instantly changes. These have terete, hollow leaves. Later, a taller kind, twice the height, with white flowers and flat, carinate leaves, appears. These have not the pleasant pinky odor of the others; but the garlicky odor is stronger. There is a variety intermediate in height between these two, with white and pink striate petals, and semi-terete leaves, channeled on the upper side.

These flowers, gathered into a bouquet, are almost everlasting in form and color, and have an everlasting smell, too. There is a tall species,

eighteen inches high, in moist places, that has bulbiferous umbels. These onions all have reticulated, fibrous bulbs. Cows are fond of the tops in spring, to the detriment of the butter. The bulbs form a large part of the food of the prairie squirrel. The low pink variety is worth cultivating, and would make a very pretty border in the flower garden early in spring.

On dry hills may be found abundance of Sophora sericea, a foot high, with its beautiful, whitish-green, silky, pinnate leaves, and terminal racemes of yellow pea-blossoms, and handsome, lead-colored calyxes.

In wet buffalo-wallows, and other wettish holes, there is a biennial species of evening primrose (Œnothera triloba), growing low to the earth, with many runcinate-pinnatisect leaves, about like those of a dandelion, and with rhomb-shaped yellow flowers, having a calyx tube three or four inches in length. When the seed is ripe and the leaves have fallen, the very short stem is entirely covered with the sessile, four-cornered capsules, as close as they can be crowded together. It much resembles, in size, shape and color, an old, over-grown pine cone.

A very showy species of trailing verbena is in blossom very early in May. It makes a pretty bed.

Early in May, the mallows all come into bloom. The scarlet mallow (Malvastrum coccineum) grows very abundantly nearly everywhere, on erect stems, ten inches high, and several to many blossoms open at the same time on each stem. These are really pretty flowers in a bouquet, and make a very pretty bed, when growing close together.

The crimson mallow (Callirrhoe involucrata) is one of the most showy flowers growing on the prairie. They are a bright crimson, with white centers, like a portulaca, and change to purple in drying. I have found them quite double. In certain spots they are to be found in great abundance, continuing to bloom all summer. The root is perennial, one to two or more inches in diameter, abounding in mucilage, and is eaten by Indians.

Another mallow (also a Callirrhoe) grows in damp places, on a weak stem eighteen inches high, and has white or pinkish petals, often fringed. The lower leaves are triangular, almost entire, a little above they are strongly crenate, and the upper leaves, still triangular in outline, are three to seven-parted, and the segments variously lobed and cleft.

Among dry rocks grows a very interesting little heath-like composite (Diplopappus ericoides), three inches high, one of the earliest composites to bloom.

Poa compressa, a species of blue-grass, is found in abundance along water-courses.

Buchloe dactyloides, the famous buffalo grass of the plains, otherwise called curly or summer mesquite, is in full bloom by the middle of May. The staminate blossoms, with their orange anthers, are quite noticeable as they stand four or five inches high, but the pistillate blossoms are hidden under the grass, about one to two inches high, and must be sought attentively to be found, and may then be found in abundance. It is remarkable, the provision made for this grass to withstand drouth. I have traced the roots in a new well to a depth of full fifteen feet from the surface, reaching quite down to that stratum of earth seldom affected by summer heat.

Two species of pentstemon, twelve or eighteen inches, found in very dry sand-hills, both with very glaucous, waxy-looking, entire leaves, one

with handsome, white or pinkish blossoms, the other with large, beautiful, blue blossoms. I have not succeeded in drying any of them without spoiling the color of the leaves.

Ceanothus Americanus, "red-root" or Jersey tea, is an abundant shrub in similar situations. If this plant was not a favorite in revolutionary times, its appearance deceives, for each of the petals, which rises on a little claw, tries to cover the pistil, and is shaped just like Israel Putnam's three-cornered hat of old.

About the middle of the month, the handsome spiderwort (Tradescantia Virginica) comes into bloom. It is abundant everywhere, and is one of the most noticeable flowers of the prairies. The flowers vary, through all shades of purple, from a very pale blue to a bright rose color. The extremes are not often found, and pure white ones are rarely found, though white ones with pink stamens sometimes appear. I have found them quite double. In one case a single flower had eight petals and sixteen stamens. They are, no doubt, capable of much improvement by cultivation.

On ground broken by gophers, and on new "breaking," we find the elegant little Gaura coccinea, ten or twelve inches high. Its flowers, when they first open, are white, soon change to rose color, and finally to scarlet before fading. It is one of the very few prairie flowers that is pleasantly fragrant.

About the 20th of May, on dry hillsides, I find plenty of Pyrrhopappus grandiflorus, (I know of no shorter name,) with brilliant yellow, dandelion-like flowers, two inches across, which are rendered more showy by contrast with the black anthers. The flower is single, on a solid, striate, one-bracted scape, rising from a radical stem, which in turn rises from a small, whitish, spongy tuber, three or four inches deep in the ground. I have never seen but one stem from one tuber; but frequently the stem is branched at or below the surface of the earth, and several scapes may arise in succession, each bearing one head. Frequently the stem may be destroyed, or even the top of the tuber cut off, in which case the tuber throws up a new stem from an almost invisible eye. The leaves, which may be called radical, are mostly at the top of the subterranean stem, and are fewer, shorter, and not so deeply gashed as dandelion leaves. The juice is milky, like lettuce. The pappus is not fiery red, as might be supposed from the name, but a tawny white. The stem has two or three scales with dormant buds between the leaves and the tuber; the tuber has several almost invisible eyes.

Other flowers blooming at the same time are Baptisia australis, with its coarse-looking blue flowers, nearly always gnawed by insects; Œnothera serrulata, a half-shrubby species, with large, crumpled petals; Psoralea argophylla and floribunda; P. cuspidata, with a large inflated calyx; Aplopappus spinulosus; Asclepias speciosa; Glycyrrhiza lepidota; Schrankia uncinata, the wonderful and very fragrant sensitive brier; and many others equally interesting. Yarrow is common.

A feature in this western country is the very showy and really splendid evening primrose (Œnothera grandiflora). It opens at a time of day when most other flowers are closed for the night, and next morning has lost its brilliant color; otherwise it would be admirable. Spots that in the spring were all pink and blue and white with anemones and wild onions, in May

are purple all day with spiderworts, and yellow all night with evening primroses.

Nearly everywhere on dry prairie, and very abundant on barren prairies, in northern Barton and Rush, grows the smokeweed (Plantago gnaphaloides), with spikes eight inches high, of minute white flowers. Growing alone on barren hillsides, it gives the land a bluish-gray or smoky appearance; and further north and west, where it grows more abundantly, it is said to have been the cause of the name of the Smoky Hill.

Toward the close of the month the pincushion cactus (Mamillaria cæspitosa) opens its blossoms. The petals vary from straw color to amber. The stigmas are green. Likewise the red pincushion cactus (M. vivipara) may be found in bloom. The petals vary from a pale pink to a bright red. The stigmas are red, pink, or pure white—never green. The plant, when not in blossom, may easily be distinguished from the yellow cactus, by its having the several divergent brown spines at the end of the tubercles, in addition to the circle of white spines. The fruit, too, is green when ripe, while that of the straw-colored species is red. Otherwise they are much alike.

A charming little bloomer in dry situations is Polygala alba, ten inches high, in dense tufts of slender stems, covered with small, white, oddly-shaped flowers, that last till the seed is half ripe.

On dry, barren rocks and bluffs may be seen in its luxuriance Yucca angustifolia, otherwise called "soap-root," "Spanish dagger," etc. Its numerous long, narrow, evergreen leaves are charming in the winter when everything else has turned brown. They are frequently used by hunters as cords to hang up meat. The roots are large and very long. They are believed to have burst rocks asunder by constant growing pressure.

And now we come to the crowning glory of the season—the prairie rose. Other flowers may be more brilliant, others more fragrant, others more interesting; but there is no flower that combines the beauty, the fragrance, the sweetness, the homelikeness of the rose, or anything to equal it.

Many of the flowers of May are worthy of cultivation. As best adapted to this purpose, I would recommend the scarlet and crimson mallows, the pentstemons, the spiderwort, the little guara, the pyrrhopappus, the showy evening primrose, the shrubby evening primrose, the round cactuses, the yucca, and the rose. They will all bear cultivation, and will amply repay any pains bestowed upon them.

Early in June, in sandy spots, may be found in abundance the very interesting day-flower (Commelyna angustifolia), growing on low, grass-like plants, with beautiful deep-blue flowers, with two petals only, the third being suppressed, having a mere rudiment just visible. Curiously enough, the three stamens opposite the perfect petals are barren, and furnished with yellow cruciform glands instead of anthers, while the three stamens opposite the abortive petal are fully developed, and have large purple anthers. The long style bends down to meet the purple stamens. The flowers are very delicate and short-lived.

The wild gourd (Cucurbita perennis) is frequently found. The root is a large inverted cone, sometimes eight to twelve inches, or more, across, and throwing out numerous vines each year from the margin of the

crown. The leaves are large, rough, cordately triangular, lamina carinate, rising from the vine right and left alternately, and pointing outward. The fruit is globose, one at each leaf nearly, about the size of an orange, and striped yellow and green. It is intensely bitter.

In Stafford county, in barren alkaline lands among the sand-hills, may be found abundance of Portulaca pilosa, resembling in every respect the portulaca of our gardens, except that the rose-colored flowers are quite small.

In similar lands may be found a very rough, small, brittle species of Opuntia, with very wicked spines. These plants almost cover the ground in spots, and are a terror to horses. The joints when touched break off, and cling like a burr, and when stepped on, the spines penetrate a horse's hoof or a man's boot. I have not seen them in bloom.

The blossoms of the ordinary prickly pear (O. vulgaris) have very sensitive and irritable stamens. When touched, they spring suddenly against the pistil.

A morning glory (Ipomea leptophylla), with red blossoms four inches deep and three broad, is frequent. The plant has a large fusiform root, four to six inches thick and very tough, so that a plow cannot penetrate it.

The thistle poppy (Argemone Mexicana), with its large white flowers, four inches across, and yellow stamens, is very noticeable.

On dry prairies may be seen a species of wild four-o'clock (Oxybaphus angustifolius), tall and slender, with very narrow leaves and pretty pink flowers. These flowers open about two hours before sunset, and roll up close early next morning.

A certain tribe of Leguminosæ, including the Psoralea, Amorpha, Dalea, Petalostemon, etc., is well represented here. Common peculiarities of these plants are, that they have yellow, thick-barked, strong-scented roots, glandular or dotted leaves, and more or less imperfect flowers. Most of them bloom in midsummer. I have already mentioned Astragalus and Psoralea, which bloom earlier.

Of Amorpha there are two species (A. fruticosa and A. canescens), both common. Both have handsome little terminal spikes of sweet-scented blue flowers, the former very dark-blue, the latter sky-blue. There is only one petal—the banner—which enwraps the blossom like a cloak. The latter, which is commonly called "shoe-string," or "devil's shoe-string," is remarkable for its long, tough, slender roots. I have traced a root, not exceeding half an inch thick at the surface, straight down to a depth of twenty-six feet. Several divisions of the root, before reaching that depth, reduced the thickness to veritable strings.

Petalostemons are frequent. There are three species (P. violaceus, candidus, and villosus). The peculiarity of these flowers is that there are no petals proper, but five alternating stamens are converted into petals, four of them oblong, and the fifth one, that takes the place of the tenth stamen, cordate. They are all raised on claws.

There are three species of Dalea, namely, laxiflora, alopecuroides, and aurea. Dalea laxiflora has a peculiarity of its own. It has but nine stamens, the tenth one being converted, as in the Petalostemons, into a cordate banner. It would thus seem to form a link connecting these two genera. This plant is otherwise interesting in its beautifully plumose calyxes. The

spike is slender and loose—the flowers arranged in three ranks that run a little spirally up the stem.

Hosackia Purshiana is very common. There are two strongly-marked varieties of this species. The first is small, say six inches high, slightly branched, grows abundantly on uplands, blossoms in June, ripens in July and August, and is much eaten by sheep. The second is eighteen to twenty-four inches high, very branched, grows mainly in bottom lands, and sparsely in uplands, blossoms in July and August, and ripens in September. An important peculiarity of this variety is, that when standing alone and in nowise crowded, it throws its branches invariably north and south alternating, and its branchlets crosswise. Before the branchlets appear, the leaves face east in the morning and west in the evening. At such times the plant has a very flat appearance, being often two feet high and the same in breadth. After the branchlets grow, and the blossoms are open, that flat appearance is lost, the leaves face up, and the plant becomes a little more irregular, though the north-and-south direction of the branches is never wholly lost. The plant commences branching at about six inches high, and from that up, bears in each axil either a branch, a branchlet, or a flower. I have counted on a very large specimen upward of 300 little pods, nearly all ripe, one inch in length, and each containing about five little, hard, dark, speckled beans. That plant was nearly three feet high, and about two and a half across, north and south.

In July and August blooms, in alkaline lands, near Great Bend, a gentian-like plant, Eustoma Russelliana, with very entire, whitish, glaucous, waxy-looking leaves, and beautiful, large, purple, violet, bluish, pinkish, or white flowers. Like the penstemons, they turn dark in the press.

Around the edges of such lands grows a species of composite, Flaveria linearis. This plant is three feet high, very branched, grows rank, has angular, red, green, or striped stems, opposite leaves, and a strong smell, nearly like fire-weed. There might be on a branch 30 to 80 very small, triangular heads, packed into a dense corymb, each head having a small, yellow ray, the rays all pointing outward from a common center. Each head has, in addition to its one ray, three or four disk-flowers, that bear very small, black seeds.

I have found Liatris squarrosa, with very white flowers, instead of red.

I append a floral clock for the months of July and August:

FLORAL CLOCK.

3 A. M.—Calystegia Sepium, (withers about 10 A. M.)

4 A. M.—Ipomea leptophylla, (withers at noon.)

5 A. M.—Evolvulus argenteus, (closes at 4 P. M.)

6 A. M.—Pyrrhopappus grandiflorus, (closes at 6 P. M.., to reopen next day. Closes also in rain or dense clouds.)

7 A. M.—Callirrhoe involucrata, (closes at 6 to 7 P. M., to reopen next day.)

8 A. M.—Linum rigidum, (falls off at 4 P. M.)

8 to 9 A. M.—Specularia leptocarpa.

9 A. M.—Portulaca pilosa, (closes at 1 P. M., does not reopen.)

9 to 10 A. M.—Portulaca oleracea, (native.)

11 A. M.—Talinum teretifolium.

12 M.—Hibiscus Trionum, (naturalized.)

2 P. M.—Mamillaria vivipara, (closes at 5 P. M., to reopen next day.)

4 to 5 P. M.—Oxybaphus nyctagineus, (closes next morning.) Oxybaphus angustifolius, (closes at 5 A. M. next day.)

6 to 7 P. M.—Œnothera sinuata, (wilts next day.)

7 P. M.—Œnothera grandiflora, (opens very promptly; wilts at 7 A. M. next day.)

This clock is subject to more or less correction and regulation.

I append also a floral calendar up to July, but the list, though useful for reference, is too long to read.

Not having perfected the list beyond July, I omit it.

FLORAL CALENDAR.

MARCH.

15th.—Peucedanum nudicaule (?)

25th.—Cymopterus montanus.

APRIL.

4th.—Astragalus caryocarpus, elm.

8th.—Flowering Caroliniana, flowering currant.

10th.—Viola cucullata, wild plum.

12th.—Astragalus Mexicanus, soft maple.

13th.—Cercis Canadensis, box elder.

15th.—Troximon cuspidatum, wild gooseberry.

16th.—Draba Caroliniana.

18th.—Lithospermum longiflorum, choke cherry, Myosurus minimus.

20th.—Allium reticulatum, Baptisia leucophæa.

22d.—Oxalis violacea.

25th.—Senecio aurea.

27th.—Lathyrus linearis.

28th.—Œnothera triloba.

30th.—Sophora sericea, Verbena Aubletia.

MAY.

1st.—Astragalus Missouriensis, Callirrhoe digitata.

2d.—Oxalis stricta, Poa compressa.

3d.—Astragalus lotiflorus, Callirrhoe involucrata.

4th.—Allium reticulatum alba, Buchloe dactyloides, Smilacina stellata.

5th.—Ceanothus Americanus, Vitis riparia.

6th.—Rhus radicans, Diplopappus ericoides, Polygala alba, Linum (perenne?—a perennial,) Pentstemon (albidus?)

7th.—Malvastrum coccineum, Lithospermum canescens, Actinella scaposa, Oxytropis Lambertii.

8th.—Guara coccinea.

9th.—Onosmodium Virginicum.

10th.—Hymenopappus scabiosæus, Physalis Pennsylvanica.
11th.—Œnothera serrulata, Ampelopsis quinquefolia.
12th.—Acerates viridis, Baptisia leucantha.
13th.—Delphinium tricorne, Achillea millefolia, Tradescantia Virginica, Poa compressa.
14th.—Pentstemon (cyanathus?) Asclepias —— (melliferous), Lippia cuneifolia (lanceolata?) Acerates paniculata.
15th.—Pyrrhopappus grandiflorus, Calystegia Sepium, Psoralea argophylla.
16th.—Amorpha fruticosa, Psoralea floribunda, Evolvulus argenteus.
17th.—Linum rigidum, Gymnocladus Canadensis, Achillea millefolia, Psoralea hypogea.
18th.—Teucrium Canadense, Yucca angustifolia.
19th.—Aplopappus spinulosus, Verbena bracteosa.
20th.—Oxybaphus angustifolius, Diplopappus ericoides.
21st.—Houstonia tenuifolia.
22d.—Asclepias speciosa, Glycyrrhiza lepidota.
23d.—Œnothera sinuata, Mamillaria vivipara.
24th.—Œnothera grandiflora, Brizopyrum spicatum.
25th.—Schrankia uncinata, Apocynum hypericifolia, Mamillaria cæspitosa.
26th.—Symphoricarpus racemosus, Cornus paniculata.
27th.—Rosa blanda, Thelesperma gracile.
28th.—Plantago gnaphaloides, Lepachis columnaris.
29th.—Monarda punctata, Helianthus rigidus, Apocynum androsæmifolium.
30th.—Solanum rostratum, Hordeum jubatum.
31st.—Asclepias tuberosa aurea, Acerates longifolia, Helianthus rigidus.

JUNE.

1st.—Sisyrinchium anceps, Erigeron strigosum.
2d.—Stipa juncea.
3d.—Hosackia Purshiana.
4th.—Ipomea leptophylla, Talinum teretifolium.
5th.—Commelyna angustifolia.
6th.—Cornus circinata, Kœleria cristata.
7th.—Onosmodium Virginianum.
8th.—Lithospernum canescens.
9th.—Oxybaphus nyctagineus, Opuntia vulgaris.
10th.—Portulaca pilosa, Cucurbita perennis.
11th.—Argemone Mexicana, Lythrum alatum.
12th.—Specularia leptocarpa, Specularia perfoliata.
13th.—Acerates lancifolia, Amorpha canescens.
14th.—Solanum rostratum.
15th.—Verbena stricta, Rhus glabra, Salvia lanceolata.
16th.—Martynia proboscidea, Lygodesmia juncea.
17th.—Guara biennis.
18th.—Ruellia ciliosa.
19th.—Petalostemon violaceum.

20th.—Sambucus Canadensis.
21st.—Croton Texensis, Frœlichia floridana.
22d.—Polygala alba, Sida spinosa.
24th.—Petalostemon candidum.
25th.—Cleome integrifolia.
26th.—Polanisia uniglandulosa.
27th.—Acerates angustifolia, Cirsium undulatum, Coreopsis tinetoria.
28th.—Asclepias tuberosa, Rhus radicans.
29th.—Dalea aurea, Dalea alopecuroides.

JULY.

Petalostemon villosus, Cenchrus tribuloides, Mentzelia albicaulis, Cuscuta chlorocarpa, Desmanthus brachylobus, Stenosiphon virgatus, Gerardia purpurea, Cleomella angustifolia, Lobelia cardinalis, Salvia Pitcheri, Asclepias verticillata, Silphium laciniatum, Asclepias incarnata, Vernonia fasciculata, Liatris pychnostachya, Cassia chamæcrista, Frœlichia procumbens, Acerates rotundifolia, Asclepias verticillata nana, Polygonum persicaria, Cuscuta glomerata, Erigeron divaricatum, Paronychia Jamesii, Gaillardia pulchella, Grindelia squarrosa, Eustoma Russelliana, Flaveria linearis, Liatris squarrosa, Euphorbia marginata, Cassia Marylandica, Phaseolus diversifolius.

STONE IMPLEMENTS IN TREGO COUNTY.

By J. Savage, Lawrence.

In company with Prof. Patrick, of the State University, the writer made a short collecting tour in Trego county, Kansas, in 1878. We stopped off at the new town of WaKeeney, for headquarters, and made side-trips to different parts of the county.

The third day after our arrival, we made an excursion nine miles northwest of WaKeeney, on the Saline fork of the Kansas river, to look after some bones reported to be of large size. We found them to be the bones of a buffalo, and protruding from the alluvial soil upon the side of a draw or ravine.

It was here, at the residence of Mr. J. M. Davis, that we found numerous fragments of stone implements lying about the premises. These we readily secured through the generosity of Mr. Davis, and also made arrangements for saving any others he might afterward find. The implements thus secured, whole and in fragments, amount to several hundred pounds in weight. They consisted of stone mallets (many of them of large size), pestles, lap-stones, grinding-stones, and smoothing-stones. The smoothing-stones were many of them much worn by use, and nearly all of them were unbroken.

The bottom upon the north bank of the Saline, where most of these implements were found, was covered so thickly with tent-poles, of oak and cedar, that Mr. Davis and some of his neighbors used them for firewood nearly all summer; and what seemed to me a little singular was, that over several acres of the bottom and slope adjoining were, mixed with the coarse sand of the numerous ant-hills, many glass beads of various colors, and of recent origin. So plentiful were they, that one could find several beads in almost every little heap of sand, or rather fine gravel.

Near by this locality a stone hatchet was found, with a handle of wood already attached to it. This hatchet I was unable to see or secure, as it was mislaid or lost in removing from a dug-out to a log house. I also learned from several neighbors living near this locality, that the best and choicest hammers and other implements had been, previous to our visit, gathered up and sent away to relic-loving friends living in different localities East, thus leaving only the greatest part of the cast-away ones for our hands to gather up.

The hammers were all made of metamorphic rocks, such as quartz, quartzite, granite and scienite—rocks which are not found in any part of Kansas that we are aware of. The smoothing-stones may, or may not, have been natives of our State. The tent-poles, those that I saw, were much worn upon their tip-ends, by being dragged over long distances upon the rough ground.

LIST OF LEPIDOPTERA,

Collected Near Idaho Springs, Colorado, By the Kansas University Scientific Expedition For 1879.

By Prof. F. H. Snow, of the University of Kansas.

The following species of Lepidoptera were taken from July 26, to Sept. 8, 1879, by the writer, assisted by two scientific students of the Kansas University—Mr. Louis L. Dyche and Miss Annie E. Mozley. No little aid was also rendered by my son Willie, ten years of age, whose quick eyes discovered several species not observed by older members of the party. Our camp was located in the Chicago creek canon, within one mile of Idaho Springs, and at an estimated altitude of 7,600 feet above the sea. The Noctuidæ were nearly all taken "at sugar," and the list in this family is chiefly remarkable for the large number (40) of species of the genus Agrotis, many of which were new to science, and have been described by Prof. A. R. Grote, chiefly in the "North American Entomologist." A very interesting "find" was a single perfect specimen of Catocala relicta, which is, I think, the first capture of that "queenly" species in the Rocky-Mountain region. One new Catocala was also taken—C. pura Hulst. It is quite likely, however, that this may prove to be C. Semirelicta Grote, as was first

suggested by Mr. Herman Strecker. This suggestion was made prior to the description of the species by Mr. Hulst, from specimens of my own capture, received by him from Mr. Strecker. The list includes a few species taken during a brief expedition to Gray's Peak, the locality being especially mentioned in every such case. Among these was a new Chroysophanus, taken at the foot of the precipitous ice-mass between Gray's Peak and Irwin's Peak, down which a perilous descent had just been made. A description of this new diurnal, by Wm. H. Edwards, will be found at the end of the list. The new Halesidota was given to me by my young friend Geo. I. Cannon, of Idaho Springs, who captured it at Boulder, Col. Prof. Grote has furnished descriptions of two of the new species of Noctuidæ, for publication in connection with this list. These are Gortyna juvenilis and Hadena discors. To these new descriptions is added a reprint of descriptions of all other new species obtained by the expedition. Acknowledgments are hereby made to Messrs. Grote, Edwards, and Packard, for valuable favors in determining unknown species.

LEPIDOPTERA RHOPALOCERA.

Papilio Daunus Edw.
Parnassius Smintheus Doubl.
Pieris Menapia Feld.
Pieris Protodice Bdl. Lec.
Pieris occidentalis Reak.
Pieris Napi, var. pallida Scud.
Nathalis Iole Bdl.
Colias Eurytheme Bdl.
Colias Keewaydin Edw.
Colias Meadii Edw. Gray's Peak.
Colias Alexandra Edw.
Colias Philodice Godt. var.
Colias Scudderli Reak.
Terias Mexicana Bdl.
Danais Archippus Fab.
Danais Berenice Cram. Gray's Peak.
Euptoieta Claudia Cram.
Argy nnis Alcestis Edw.
Argynnis Eurynome Edw.
Argynnis Helena Edw.
Argynnis Edwardsii Reak.
Melitæa minuta Edw.
Phyciodes Camillus Edw.
Grapta Satyrus Edw.
Grapta Zephyrus Edw.
Vanessa Antiopa Linn.
Vanessa Milbertii Godt.
Pyrameis cardui Linn.
Pyrameis Atalanta Linn.
Limenitis Weidemeyerii Edw.
Satyrus Charon Edw.
Erebia Callias Edw. Gray's Peak.
Erebia Epipsodea Butl. Gray's Peak.
Thecla humuli Harr.
Thecla sæpium Bdl.
Thecla mopsus Hub.
Lemonias Nais Edw.
Chrysophanus Virginiensis Edw.
Chrysophanus Sirius Edw.
Chrysophanus Snowi Edw. n. sp. Gray's Peak. See description in article following this list.
Chrysophanus helliodes Bdl.
Lycæna Sæpiolus Bdl. Gray's Peak.
Lycæna orbitulus Von Prunner. Gray's Peak
Lycæna Melissa Edw.
Lycæna Isola Reak.
Eudamus Tityrus Fab.
Pamphila comma Linn.
Pamphila Uncas Edw.
Pamphila Agricola Boisd.
Prygus tessellata Scud.
Pyrgus centaureæ Rambr.
Nisoniades Persius Scud.
Pholisora catullus Cram.

LEPIDOPTERA HETEROCERA.

Deilephila lineata Fab.
Gnophæla vermiculata Grote.
Anatolmis Grotei Packard.
Lycomorpha miniata Packard.
Lithosia bicolor Grote.
Halesdota trigona Grote n. sp.
Crocota sp.
Acronycta Theodori Grote.
Agrotis baja S. V.
" rufipectus Morr.
" sexatilis Grote.
" tessellata Harr.
" decolor Morr.
" redimicula Morr.
" Ridingsiana Morr.
" 4—dentata G. and R.
" gagates Grote (equivalent to mimallonis Grote.)

" chortalis Harvey.
" aratrix Harvey.
" fumalis Grote.
" messoria Harr.
" pastoralis Grote.
" malefida Guen.
" telifera Harr.
" inconcinna Harvey.
" brocha Morr.
" turris Grote.
" albipennis Grote.
" pyrophiloides Harvey.
" sierræ Harvey.
" variata Grote.
" basalis Grote n. sp.
" munis Grote n. sp.
" mirabilis Grote n. sp.
" conchis Grote n. sp.
" olivalis Grote n. sp.
" parentalis Grote n. sp.
" cænis Grote n. sp.
" catenula Grote n. sp.
" decipiens Grote n. sp.
" minimalis Grote n. sp.
" vocalis Grote.
" atrifera Grote.
" placida Grote.
" vernilis Grote.
" verticalis Grote n. sp.
" docilis Grote n. sp.
" (Eurois) occulta Hubn.
Mamestra adjuncta Guen.
" Farnhami Grote.
" lilacina Harvey.
" trifolii Esp.
" olivacea Morr.
" acutipennis Grote.
" discalis Grote.
Hadena devastatrix Grote.
" lateritia var. dubitans Walk.
" auranticolor Grote.
" longula Grote.
" genetrix Grote.
" flavidens Grote.
" discors Grote n. sp.
Hyppa xylinoides Guen.
Oncocnemis Chandleri Grote.
Oncocnemis Glennyi Grote.
Oncocnemis homogena Grote.
Polia illepida Grote.
Laphygma frugiperda Guen.
Eupsephopæctes procinctus Grote.
Nephelodes minians Guen.
Gortyna juvenilis Grote n. sp.
Lencania Harveyi Grote.
Leucania (near) adjuta Grote.
Lencania (near) phragmitidicola Guen.
Lencania unipuncta Haworth.
Caradrina bilunata Grote.
Caradrina undet. species.
Orthosia Conradi Grote.
Orthosia n. sp. not described.
Scoliopteryx libatrix Linn.
Plusia Hochenwarthi Hoch. Gray's Peak.
Plusia Sackenii Grote.
Plusia u-aureum Boisd.
Anarta melanopa Thunb. Gray's Peak.
Anarta nivaria Grote. Gray's Peak.
Euleucyptera cumatilis Grote.
Lygranthœcia brevis Grote.
Melicleptria villosa Grote.
Heliothis armiger Hubn.
Heliothis nuchalis Grote.
Pyrrhia stilla Grote n sp.
Drasteria erechtea Hub.
Melipotis pallescens G. and R.
Catocala relicta Walk.
Catocala pura Hulst. n. sp. (equivalent to semirelicta?)
Catocala briseis var. Grotiana Bailey.
Catocala briseis var. Hermia Hy. Edw.
Catocala aspasia Streck (equivalent to Walshii?)
Catocala perdita Hy. Edw.
Homophyralis n. sp. not described.
Hypena humuli Harr.
Eupithecia miserulata Grote.
Glaucopteryx cæsiata Borkh.
Glaucopteryx magnoliata Guen.
Petrophora prunata Linn.
Petrophora (near) nubilata Pack.
Ochyria munitaria Hubn.
Ochyria lignicolorata Pack.
Thamnonoma tripunctaria Pack.
Thamnonoma subcessaria Pack.
Thamnonoma flavicaria Pack.
Phasiane trifasciata Pack.
Semiothisa granitata (?) Guen.
Aplodes rubrifrontaria Pack.
Cymatophora humaria Guen.
Gnophos Haydenata Pack.
Cleora umbrosaria Pack.
Opisthograptis suphuraria Pack.
Sicya macularia Harr.
Therina fervidaria Hubn.
Azelina Hubneraria Guen.
Tetracis Colorodaria Pack.
Nomophila noctuella S. V.
Botis socialis Grote.
Eurycreon sticticalis Linn.
Eurycreon cerealis Zeller.
Pterophorus undet. species. Gray's Peak.

Number of species: Rhopalocera, 53; Heterocera, 127; total, 180 species.

NEW WESTERN NOCTUIDÆ.

By A. R. Grote, New York.

The forms noticed in this paper were collected by Prof. F. H. Snow, at Idaho Springs, Colorado. The first two descriptions are here published for the first time; the remainder appeared in the North American Entomologist, November and December, 1879, except Catocala pura and Agrotis verticalis, which were published in the Bulletin of the Brooklyn Entomological Society, April and August, 1880.

Hadena discors n. sp.

The hind wings are white, with black, distinct, incompletely-broken terminal line, fringes faintly interlined, uneven, veins and terminal space slightly dusted with fuscous. The eyes are naked, abdomen tufted at base and thorax on the dorsum; the antennæ are pyramidal, ciliate. Anterior wings reddish-brown and blackish, slightly dusted with ochery scales. The style of ornamentation recalls castanea or the grandis group of Mamestra. A narrow black basal dash, and one below it on internal margin. Lines double, black, indistinct. Anterior line upright, thrice dentate, its outer component line marked with black and more distinct. Median space stained with reddish brown. Claviform moderate, acute, lined in black and connected by a black dash with posterior line. Orbicular speckled with ochery, rounded, slightly oblique, rather large. Reniform resembling orbicular in color, with faint interior annulus, upright, extending below median vein, which also shows scattered ochery scales. Posterior line dentate opposite the cell, badly defined superiorly, marked in black on its inner component line on submedian space opposite the claviform. Subterminal marked by three pale interspacial flecks between veins two and five, a black streak opposite the cell and one below vein two. Terminal space narrow, blackish, fringes dusky brown, finely cut with pale. Thorax with a fine line or collar, tegulæ lined with black. Beneath whitish, with distinct black discal marks. The dentate fringes brownish, before them a black interrupted line. The wings show reddish stains. The abdomen is fuscous above, laterally and beneath, reddish or purplish. Expands 40 mil.

Gortyna juvenilis n. sp.

Eyes naked, front smooth, tibiæ unarmed, middle pair with rather long scales covering the joint; form slender, wings rather long and narrow, apices acute. Light yellow, ornamentation rather like sera, lines and spots present. All three stigmata concolorous, subequal, claviform smallest, orbicular round, reniform obovate, narrowing inferiorly, where it is touched with white. The linear angulate brown median shade is continuous between the discal spots. In the female the median space is shaded with dusky. Lines single, outer line scalloped on the interspaces. Terminal space darker than

the rest of the wing, divided by the fuscous s. t. line which hardly reaches the apices, seeming to reach external margin at vein seven; fringes and external margin reddish fuscous. Hind wings dark fuscous, very dark and contrasting in the female, fringes reddish fuscous. Body yellowish, concolorous with fore wings. Male antennæ shortly ciliate, female simple. Beneath both wings yellowish, shaded with reddish fuscous, with faint common exterior line. This species is recognizable from its slender make, the contrast of the fuscous secondaries with their under surface and with the primaries. Expanse 28 to 29 mil.

Halesidota trigona n. sp.

By its almost vermilion-red abdomen above, allied to the California Edwardsii. Fore wings blackish or dark lead color, with scattered red and dark scales, and a lilac tint about internal angle. A large, irregularly-triangular pellucid costal patch beyond the cell, its base along the costa, which is here yellowish, but narrowly crimson at the base. This patch is bordered with yellow, and shows scattering dots of dark scales. There are two small, rounded yellow spots, one within and below the other, on internal margin at basal third. A red and yellow terminal line at base of fringes, which are dark, interrupted with yellow at end of veins. Hind wings white, washed with bright red. Abdomen, above bright red, below white. Legs white, with the front pair bright red within on femora, and with dusky tibiæ and tarsi. Fore wings beneath largely red; the transparent patch shaded with yellow, and without dots. Head and thorax lead color; latter shaded with red and yellow, beneath white. Expanse 45 mil.

To the preceding description, as published in the North American Entomologist, Mr. Grote adds the following: "Closely resembles the Brazilian specularis, H.—S., Exot. Fig. 59. It differs by the smaller size of the vitreous spot, the outer edge of which is farther from the external margin, and more even—less scalloped. The Brazilian species wants the yellow terminal shade-line. There is a great resemblance between the two widely geographically separated forms."

Agrotis mirabilis n. sp.

Fore tibiæ unarmed; male antennæ simple. Blackish fuscous; terminal space paler, powdered with grayish. Lines obliterate. Median lines approximate. Subterminal defined by difference of shade. Discal spots contrasting, yellowish or ochery white in a black shade; orbicular reduced, reniform moderate, subquadrate. A whitish dot in front at insertions of fore wings. Head collar and tegulæ concolorous; dorsum of thorax pale reddish, contrasting; tegulæ with indistinct inner black edging. Hind wings dark fuscous, with pale interlined fringes. Beneath dark fuscous powdered with grayish; on primaries the inception of common line marked in black, and costal dots. Expanse 36 mil. Allied to discoidalis, but very different in color.

Agrotis basalis n. sp.

All the tibiæ spinose. Male antennæ brush-like. By its brown-red color allied to gagates; but the basal space is shaded with grayish clay color.

Lines double, marked by dots on costa. Terminal space dull blackish, contrasting with the rest of the wing. Subterminal line powdery, pale. Stigmata prominent, discolorous, grayish, with black annuli margined within by a whitish ring. Orbicular well sixed spherical; reniform upright, curved, of the usual shape. Fringes fuscous. Hind wings smoky fuscous, with pale, interlined fringes; paler in the male. Abdomen reddish beneath. Head and thorax brownish red. Wings beneath with obliterate markings; costa powdered with red. Three specimens. Expanse 40 mil.

Agrotis munis n. sp.

All the tibiæ armed; male antennæ brush-like. Of a peculiar lilac gray, rather pale, with distinct ornamentation, recalling euroides. Lines single, black, well written, dentate. Stigmata concolorous; claviform sharp, outlined in blackish. Reniform and orbicular large, vague; cell black between them. Subterminal line broken into shade marks, better marked on costa. Median shade marked below the reniform. Hind wings pale fuscous, with concolorous fringes and discal mark. In the male paler, allowing double extra-mesial shade lines to be visible. Beneath with discal lunules and extra-mesial subdentate common shade line. Palpi dark at the sides. Resembles Fernaldi, but the lines are narrower, the subterminal line is broken into blackish patches, the extra-mesial line is not angulate on the secondaries. Expanse 35 to 40 mil.

Agrotis conchis n. sp.

All the tibiæ spinose. Allied to C. nigrum; recalls Hilliana by the brightness of the ocher stigmata. Fore wings light lilac gray, smooth, with a blackish tone. Base ocher, bounded by the half-line. Orbicular light ocher, open to costa, outwardly oblique. Reniform upright, wide at base, with a deep ocher interior ring. Median lines wide apart. Exterior line evenly scalloped, followed by points. Subterminal space darker, with blackish costal shade. Subterminal line followed by a pale shade line. Terminal space like s. t., gray at apices. Disk between and about the stigmata clouded with rich blackish brown. Claviform indicated. Median shade apparent below reniform. Head and collar bright ocher; tegulæ brownish ocher; dorsum very pale dusty ocher. Hind wings with a pale ochery ground, shaded with fuscous. Beneath, pale, with common continued scalloped line and discal lunules open on primaries. Abdomen light brownish ocher; breast light brownish; palpi dark brown at sides. Expanse 40 mil.

Agrotis olivalis n. sp.

All the tibæ spinose. Allied to ridingsii. Dark olive with clear bluish white stripes and markings. Collar with a mesial dark line. Thorax in front crossed by a black line followed by a white band. Costa shaded with white; median vein narrowly striped with white. Transverse posterior line followed by white shadings, spreading from the veins, crossing the s. t. line below apices, at the median nervules again, and at internal margin; these white shades are alternated with black cuneate marks. Orbicular narrow, oblique, white, with narrow dark center, filled in with white next the annulus; claviform concolorous, long, black-edged. A black, even terminal

line. Hind wings fuscous with whitish, interlined fringes. Beneath with double extramesial diffused shade lines and faint discal marks. Thorax dark olive; abdomen fuscous. Expanse 32 mil.

Agrotis parentalis n. sp.

All the tibiæ spinose; antennæ simple, ciliate beneath. Allied to decipiens, but quite different in color. Lines deep black. General color gray, suffused with reddish-brown. Median space darker. Basal half-line deep black. Median lines, dentate and excavate, deep black, approximate. Costal region diffusely gray shaded. Claviform moderate, deep black. Orbicular concolorous, large, rounded. Reniform subequal, upright, subquadrate; disk blackish. Exterior line, moderately produced and excavate, marked by vein points. Subterminal line faint, vague, broken. A fine slightly uneven terminal black line. Fringes concolorous. Hind wings pale fuscous, with reddish fringes concolorous with those on primaries. Thorax concolorous, with mesial ridge, without markings except a faint line on collar. Beneath pale, tinged with reddish, with traces of a common line. Expanse 38 mil.

Agrotis caenis n. sp.

Allied to lubricans, but without any line on the collar; the t. p. line more inwardly oblique. Dark gray, shaded and splashed with red. Markings all indistinct and the lines broken. Orbicular round, moderate, gray, with darker center; reniform of the usual shape, upright, excavate outwardly, gray, with dark center. Lines marked by black and pale costal dots. Fringes fuscous with a pale line at base. Thorax and head concolorus with fore wings, shaded with reddish; palpi black at the sides. Hind wings white, with white fringes and diffusely shaded with fuscous along exterior border. Beneath, hind wings white, fore wings pale fuscous. Expanse 42 mil.

Agrotis catenula n. sp.

All the tibiæ spinose; male antennæ brush-like. Allied to muraenula; differs in color, and t. p. line not followed by white dots. Gray white, indistinctly olivaceous or ochraceous, concolorous; thorax immaculate. Palpi with black scales on basal and second joint at the sides. Lines indicated by black costal spots. Orbicular, a black mark; reniform, reduced, black. Exterior line broken into black dots, a large dot on internal margin and costa. Half-line indicated; t. a. line incomplete; subterminal obsolete; a maginal row of black points. Fringes concolorus. Hind wings pellucid white, with white fringes clouded with fuscous along external margin, and with the veins soiled. Beneath whitish; cell of primaries fuscous; a discal lunule and faint exterior line; a black dot on hind wings. Expanse 36 mil.

Agrotis decipiens n. sp.

All the tibiæ spinose. Rather slender bodied and long winged. Belongs to Ammoconia, since the thorax shows a sharp mesial ridge. Leaden gray, concolorous, the median space clouded with blackish. Orbicular large, rounded or slightly oblique, gray, or with darker center; reniform large, upright, slightly mesially constricted. Lines indistinct, double; half-line

black, single. Subterminal space gray, in one specimen this and the internal margin shows a faint brownish tinge. Subterminal line commencing with a blackish shade and then running outwardly and near the margin, leaving the apices gray. Beneath with a faint purplish tinge. Breast purplish black. Wings with common line, double on primaries, marked on the veins on hind wing, and faint discal dots. Male antennæ simple, ciliate. Expanse 38 mil.

Agrotis minimalis n. sp.

Allied to placida, but reddish like cupida. Fore tibiæ unarmed. Orbicular small, round, paler, with dark center; reniform small, dark. Median shade, diffuse, continuous, evident below reniform. Lines single, blackish, followed by pale shades. Subterminal space dark red and contrasting with pale terminal. A terminal row of dots, fringes concolorous. Hind wings fuscous with concolorous fringes. Head and thorax reddish, concolorous. Abdomen fuscous, flattened, with reddish anal hairs. Wings beneath fuscous, shaded with red, with common line distinct on secondaries, on primaries marked on costa. Discal dots better marked on hind wings. Palpi black on sides. Expanse 33 mil.

Agrotis verticalis n. sp.

Allied to tessellata and campestris. Hind wings of the male white, like albipennis; of the female, white, dusted with fuscous; in the male, a narrow fuscous bordering before the white interlined fringes. Fore wings smooth, dusky gray. Lines geminate, black; basal half-line distinct, and like the anterior line, with an included pale streak. Orbicular large, ovate, decumbent, neatly black-ringed, the ring finely edged inwardly with pale. Reniform upright, ringed as orbicular, well-sized; both stigmata concolorous. Cell shaded before the orbicular, and centrally and again beyond the reniform, with reddish-brown in the female; in the male this is absent, or replaced by a faint blackish shading. Subterminal space shaded with reddish brown, or blackish on costa, where it includes pale ante-apical costal points. Posterior line distinct on costa above the reniform, where it is like the other lines; below, it becomes faint and denticulate. Subterminal line as in campestris, pale. Terminal space blackish, leaving the apex paler. Two specimens similarly sized with campestris.

Pyrrhia stilla n. sp.

Bright orange red, allied to angulata, rather than to exprimens. Base of primaries bright smooth orange, without markings. Median shade strongly contrasting, deep brown, forming a mesial band, acutely angulate on cell, even, diffuse exteriorly. Stigmata obsolete. Exterior line as in angulata, obsolete on costa. Subterminal subobsolete. Fringes with a bright red tint. Hind wings light yellow with blackish lunule, blackish at base, with a broad, vague, blackish band, tinged with reddish outwardly. Beneath yellow; fringes on primaries red; a red exterior band touched with blackish inferiorly; a discal lunule. Secondaries with a diffuse red exterior band, faint discal mark, above which costa touched with red. Expanse 36 mil.

To the preceding descriptions by Mr. Grote, is added the following by

Mr. Geo. D. Hulst, of Brooklyn, N. Y., which completes the list of new species of Noctuidæ taken at Idaho Springs, Colorado, by the Kansas University Scientific Expedition of 1879.

Catocala pura n. sp.

Expands three inches. Head gray; palpi gray, black on tips; thorax gray, collar and tegulæ edged with indistinct shading; body gray, with a brownish tinge; anal tuft lighter. Fore wings with ground color very light, giving much the same general appearance as Semirelicta; surface squamose; markings generally indistinct. Base a little more darkly marked, making an indistinct basal dash; subreniform closed; t. p. line with the two main dentations spreading and not largely produced, the lower especially, and with the dentations beneath these somewhat exaggerated, giving an irregularly-serrated appearance; submarginal line quite distinct, and against the white surface color showing very clearly its serrations; fringe gray. Hind wings red as in Briseis, median band as in Californica, but narrower, and prolonged hardly more than two-thirds across the wing; fringe pure white. There is no shading of red on the outer edge or the apex of the wing. Underneath the wings are much as in Californica, but with the median band narrowed, and ending posteriorly in a round bulb.

DESCRIPTION OF A NEW SPECIES OF CHRYSOPHANUS.

By W. H. Edwards, Coalburgh, West Va.

C. Snowi.

Male: Expands 1.2 inch.

Upper side copper-red, very nearly the hue of C. Americana; and as in that species, having the hind margins of all wings broadly fuscous; costa of primaries fuscous, primaries have a transverse discal of six or seven small black spots or points, four of which are in an oblique straight line from costa to median; the others a little within this line in the median interspaces; at the end of cell a long black spot, and a second, minute, at one-third the distance from arc to base.

Secondaries have a slightly sinuous discal row of similar spots, and between this and the margin on posterior half of the wing are indistinct fuscous spots.

Under side of primaries reddish-ochraceous on disk, gray over costal and hind margins and at base; a submarginal row of small fuscous spots; the discal row repeated, a little enlarged; the spots in cell repeated, the one on arc made up of two confluent round spots.

Secondaries gray with a reddish tint, the base and inner margin dusted black, a submarginal row of small black spots, the one next to anal angle largest, and nearly covered with orange, the next two a little dusted orange;

behind each of these three is a black point; the discal spots repeated; in cell three spots, and two on costal margin.

Female: Expands 1.25 inch.

Color lighter, more yellowish; margins bordered as in male; all spots as in male, but larger; two spots at end of cell on secondaries.

Under side as in male, but there is a third spot in cell of primaries near base; on secondaries there are three distinct spots in line across basal area, and three parallel to these a little beyond, besides two at end of cell—in all eight spots within the discal row.

From two males and one female, taken by Prof. F. H. Snow, above timber line on Gray's Peak, Colorado.

This species is nearest Cupreus Edw., but differs in several respects, and partakes of the character of some other American species. It is larger than Cupreus (known to me only from Oregon and California). The color of male is almost same as in Americana, and in the broad marginal borders there is another point of resemblance; the spots are disposed nearly as in Cupreus, but the rows are less regular; so too the color of under side is like Cupreus, but the spots are not edged buff, and instead of a complete series of orange spots across secondaries within the margin (much as in Americana, only here the spots are confluent), Snowi has a series of black spots, one only being almost concealed by orange.

LIST OF COLEOPTERA COLLECTED IN SANTA FE CANON, NEW MEXICO.

By the Kansas University Expedition For 1880.

By. Prof. F. H. Snow.

The camp in the vicinity of which the 237 species of Coleoptera in the following list were collected was situated eight miles from the city of Santa Fe, at an elevation of 7,000 feet above the level of the sea. The party was in the field for four weeks, from August 6th to September 3d, and consisted of the family of the writer, together with Mr. Louis L. Dyche and Miss Annie E. Mozley—students of the University of Kansas. My son and daughter, Willie and Mattie, eleven and ten years of age, obtained several species not collected by the other members of the party. Among the new species discovered was a large and polished Onthophagus, of which Dr. Le Conte writes that it is "the most extraordinary addition to our fauna discovered for a long time." Three specimens were obtained of the rare and curious Amphizoa Le Contei, a species which had not previously been detected within the limits of the United States.

Drs. Le Conte and Horn, to whom I am indebted for many favors in the determination of species, have kindly furnished descriptions of that portion

of the new species which could be published separately without confusion to science.

The conspicuous scarcity in Santa Fe canon of Chrysomelids and some other families of beetles, as well as of the Lepidoptera, both diurnal and nocturnal, is probably due to the very numerous flocks of sheep and goats, which destroy the food plants of these insects.

LIST OF COLEOPTERA.

CICINDELIDÆ.

12. Cicindela longilabris Say.
28. Cicindela vulgaris Say.
30b. Cincindela guttifera Lec.
51. Cincindela punctulata Fab.
51a. Cincindela micans Fab.

CARABIDÆ.

72. Omophron americanum Dej.
116. Nebria obliqua Lec.
155. Carabus serratus Say.
160. Carabus tædatus Fab.
173. Cychrus elevatus Fab.
——. Cychrus Snowi Lec. n. sp. (See description by Dr. Leconte, at end of this list.)
200. Pasimachus elongatus Lec.
220. Dyschirius globulosus Say.
380. Metabletus americanus Dej.
397. Cymindis laticollis Say.
399. Cymindis abstrusa Lec.
428. Calathus ingratus Dej.
436. Calathus dubia Lec.
457. Platynus sinuatus Dej. var.
——. Platynus nivalis Horn, n. sp. (See description by Dr. Horn, at the end of this list.)
481. Platynus cupripennis Say.
514. Platynus placidus Say.
581. Pterostichus protractus Lec.
7522. Pterostichus longulus Lec.
638. Pterostichus Luczotii Dej.
685. Amara latior Kirby.
701. Amara confusa Lec.
704. Amara erratica Sturm.
705. Amara lævipennis Kirby.
711. Amara terrestris Lec.
713. Amara remotestriata Dej.
819. Piosoma setosum Lec.
894. Bradycellus nigrinus Dej.
917. Selenophorus troglodytes Dej.
925. Harpalus retractus Lec.
926. Harpalus amputatus Say.
933. Harpalus compar Lec.
940. Harpalus herbivagus Say.
945. Harpalus ellipsis Lec.
950. Harpalus montanus Lec.
955. Harpalus funestus Lec.
959. Harpalus ochropus Kirby.
976. Stenolophus conjunctus Say.
1015. Trechus chalybeus Mann.
1059. Bembidium transversale Dej.
1062. Bembidium lugubre Lec.
1063. Bembidium striola Lec.
1065. Bembidium bimaculatum Kirby.
——. Bembidium n. sp.
1067. Bembidium lucidum Lec.
1072. Bembidium picipes Kirby.
1097. Bembidium intermedium Kirby.
1114. Bembidium connivens Lec.
1116. Bembidium assimile Gyll.
1119. Bembidium quadrimaculatum Linn.
1143. Tachys nanus Gyll.
1156. Tachys incurvus Say.

AMPHIZOIDÆ.

1171. Amphizoa Lecontei Matth.

DYTISCIDÆ.

1210. Hydroporus nubilus Lec.
1227. Hydroporus obesus Lec.
1229. Hydroporus striatellus Lec.
1261. Hydroporus vilis Lec.
1279. Laccophilus proximus Say.
1281. Laccophilus decipiens Lec.
1317. Rhantus binotatus Harr.
1334. Ilybius biguttatus Germ.
1342. Ilybiosoma regularis? Lec.
——. Gaurodytes Austinii Lec.
1351. Gaurodytes semipunctatus Kirby.
1363. Gaurodytes intersectus Cr.
1375. Gaurodytes tristis Aube.
1379. Gaurodytes lugens Lec.
1381. Anisomera cordata Lec.

HYDROPHILIDÆ.

——. Hydraena n. sp. (?)
1450. Tropisternus nimbatus Say.
1453. Tropisternus Californicus Lec.
1455. Tropisternus glaber Hb.
1457. Tropistermus ellipticus Lec.
1481. Laccobius ellipticus Lec.
1489. Philhydrus nebulosus Say.
1497. Philhydrus diffusus Lec.
1504. Philhydrus fimbriatus Mels.
1507. Hydrobius fuscipes Linn.
1511. Hydrobius scabrosus Horn.
1514. Hydrobius infuscatus Mots.
1516. Hydrobius subcupreus Say.

STAPHYLINIDÆ.

——. Homalota Sp. (?)
——. Placusa Sp. (?)
1647. Tachyusa nigrella Lec.
1662. Aleochara bimaculata Grav.
——. Aleochara Sp.
——. Tachinus Sp. (?)

1749. Heterothops fumigatus Lec.
1752. Quedius explanatus Lec.
1771. Creophilus villosus Grav.
1782. Staphylinus fossator Grav.
1804. Philonthus californicus Mann.
1815. Philonthus scybalarius Nord.
1816. Philonthus debilis Grav.
——. Philonthus triangulum Fauv.
7769. Dianous nitidulus Lec.
7788. Oxyporus occipitalis (?) Fauv.
1972. Bledius ornatus Lec.
1988. Platystethus americanus Er.
1991. Oxytelus fuscipennis Mann.
——. Trogophloeus Sp. (?)
7841. Geodromicus ovipennis Lec.

SILPHIDÆ.

2176. Necrophorus marginata Fab.
2178a. Necrophorus Hecate Bland.
2188. Silpha lapponica Hb.
2194. Silpha truncata Say.

DERMESTIDÆ.

2392. Dermestes marmoratus Say.
2404. Dermestes maculatus Deg.
2434a. Orphilus subnitidus Lec.

ENDOMYCHIDÆ.

2441. Mycetina morosa Lec.

EROTYLIDÆ.

2541. Cypherotylus Boisduvali Chev.

COLYDIIDÆ.

8019. Bothrideres montanus Horn.

TROGOSITIDÆ.

2688. Tenebrioides corticalis Mels.
2698. Ostoma Pippingskoeldi Mann.

NITIDULIDÆ.

2729. Carpophilus pallipennis Say.
2667. Meligethes ruficornis Lec.
2772. Perthalycra Murrayi Cr.

CONCINELLIDÆ.

2832. Hippodamia convergens Guer.
2848. Coccinella 5-notata Kirby.
2853. Cycloneda sanguinea Linn.
2864. Anatis subvitata Muls.

CISTELIDÆ.

8092. Limnichus analis Lec.

ELMIDÆ.

——. Elmis concolor Lec. n. sp. See description by Dr. Le Conte, at the end of the list.
8087. Elmis divergens Lec.

PARNIDÆ.

1977. Helichus striatus Lec.

HISTERIDÆ.

3049. Hister abbreviatus Fab.
3053. Hister depurator Say.
3134. Saprinus oregonensis Lec.
3158. Saprinus fimbriatus Lec.
8119. Teretrius montanus Horn.

LUCANIDÆ.

3205. Lucanus mazama Linn.
3210. Platycerus depressus Lec.

SCARABÆIDÆ.

3219. Canthon praticola Lec.
——. Onthophagus coproides Horn. n. sp. See description by Dr. Horn, at the end of this list.
3247. Onthophagus Hecate Fabr.
3255. Aphodius hyperboreus Lec.
3261. Aphodius crassulus Horn.
3262. Aphodius ursinus Mots.
3263. Aphodius ruricola Mels.
3269. Aphodius vittatus Say.
——. Aphodius n. sp. near pectoralis Lec.
——. Rhyssemus cælatus Lec. n. sp. See description by Dr. Le Conte at the end of this list.
3381. Trox alternans Lec.
3394. Trox atrox Lec.
3456. Diplotaxis brevicollis Lec.
3560. Listrochelus falsus Lec.
3615. Aphonus tridentatus (?) Say. Determined from a single elytron found among the debris on the banks of the Santa Fe river.
3619. Aphonus clunalis Lec.
3646. Euphoria inda Linn.
3659. Cremastochilus Knochii Lec.

BUPRESTIDÆ.

3718. Buprestis maculiventris Say.
3722. Buprestis lauta Lec.
3734. Melanophila Drummondi Kirby. Var.
3747. Chrysobothris femorata Lec.
3756. Chrysobothris trinervia Kirby.
3790. Acmæodera ornata Fab.
3791. Acmæodera puchella Hbst.

ELATERIDÆ.

3902. Anelastes Drurii Kirby.
3953. Cardiophorus longior Lec.
8258. Athous cribratus Lec.
3983. Cryptohypnus bicolor Esch.
3995. Cryptohypnus pectoralis Say.
4297. Corymbites rupestris Germ.

LAMPYRIDÆ.

8293. Dictyoptera ruficollis Lec.
——. Caenia sp.
4450. Photinus corruscus Linn.

TELEPHORIDÆ.

4482. Chauliognathus scutellaris Lec.

MALACHIDÆ.

4582. Collops bipunctatus Say.
4584. Collops 4-maculatus Fab. var.

4628. Attalus morulus Lec.
——. Pristoscelis comatus Lec. n. sp. See description by Dr. Le Conte at the end of this list.

CLERIDÆ.

4720. Trichodes apivorus Germ.
——. Clerus n. sp.
——. Lebasiella discoidea Lec. See description by Dr. Le Conte at the end of this list.
4789. Corynetes rufipes Fabr.

PTINIDÆ.

4809. Ptinus interruptus Lec.

CERAMBYCIDÆ.

4931. Criocephalus productus Lec.
5051. Rhopalophora longipes Say.
——. Rhopalophora longipes Say, var. A singular variety in which the prothorax is black instead of red. It is suggested by Dr. Le Conte that this difference in color is perhaps the result of disease.
5068a. Tragidion fulvipenne Say.
5120. Zylotrechus undulatus Say.
5321. Monohammus maculosus Hald.
5377. Acanthocinus obliquus Lec.
5378. Acanthocinus spectabilis Lec.
5388. Pogonocherus mixtus Hald.

CHRYSOMELIDÆ.

5668. Zanthonia 10-notata Say.
5672. Heteraspis marcassita Germ.
5831. Monoxia guttulata Lec.
5875. Graptodera plicipennis Mann.
5942. Chaetocnema denticulata Ill.

TENEBRIONIDÆ.

6010. Epitragus canaliculatus Say.
6068. Asida opaca Say.
6127a. Eleodes dispersa Lec.
6134. Eleodes quadricollis Esch.
6137. Eleodes extricata Say.
6149. Eleodes nigrina Lec.
6161. Eleodes consobrina Lec.
6163. Eleodes planipennis Lec.
6202. Ipthimus serratus Mann.
6244. Blapstinus pratensis Lec.
——. Platydema, undetermined species.

ALLECULIDÆ.

6375. Hymenorus obscurus Say.
8643. Mycetochares lugubris Lec.

OTHNIIDÆ.

6404. Othnius umbrosus Lec.

ANTHICIDÆ.

6479. Anthicus floralis Payk.

MELANDRYIDÆ.

6552. Zilora hispida Lec.
6555. Serropalpus striatus Helen.
6563. Hallomenus punctulatus Lec.

MORDELLIDÆ.

6579. Anaspis nigra Hald.
6558. Mordellistena angusta Lec.

MELOIDÆ.

——. Meloe near rugipennis Lec.
6803. Zonitis atripennis Say.
6804. Zonitis flavida Lec.
6808. Nemognatha bicolor Lec.
6809. Nemognatha lurida Lec.
——. Nemognatha lurida var.
6824. Nemognatha cribraria Lec.
6825. Nemognatha immaculata Say.

OEDEMERIDÆ.

——. Ditylus undetermined species.

OTIORHYNCHIDÆ.

8785. Peritaxia rugicollis Horn.
8833. Pandeleteius hilaris Hbst.

CURCULIONIDÆ.

8950. Cleonus near frontalis Lec.
8993. Dorytomus brevicollis Lec.
9067. Magdalis cuneiformis Horn.
9405. Balaninus uniformis Lec.

CALANDRIDÆ.

9425. Sphenophorus Ulkei Horn.
9467. Cossonus concinnus Boh.
9485. Rhyncolus brunneus Mannh.
——. Rhyncolus undetermined species.

SCOLYTIDÆ.

——. Platypus n. sp.
9619. Dendroctonus terebrans Oliv.
9589. Scolytus Californicus Lec.
9637. Hylastes gracilis Lec.
9643. Hylurgops rugipennis Mannh.

SUMMARY OF SPECIES.

Cicindelidæ	4
Carabidæ	52
Amphizoidæ	1
Dytiscidæ	15
Hydrophilidæ	13
Staphylinidæ	21
Silphidæ	4
Dermestidæ	3
Endomychidæ	1
Erotylidæ	1
Colydiidæ	1
Trogositidæ	2
Nitidulidæ	3
Coccinellidæ	4
Cistelidæ	1
Elmidæ	2
Parnidæ	1

Histeridæ	5	Alleculidæ	2
Lucanidæ	2	Othniidæ	1
Scarabaeidæ	18	Anthicidæ	1
Buprestidæ	7	Melandryidæ	3
Elateridæ	6	Mordellidæ	2
Lampyridæ	3	Meloidæ	8
Telephoridæ	1	Oedemeridæ	1
Malachidæ	4	Otiorhynchidæ	2
Cleridæ	4	Curculionidæ	4
Ptinidæ	1	Calandridæ	4
Cerambycidæ	8	Scolytidæ	5
Chrysomelidæ	5		
Tenebrionidæ	11	Total: families, 41; species	237

DESCRIPTIONS OF NEW SPECIES OF NORTH AMERICAN COLEOPTERA.

By Dr. Jno. L. Le Conte and Dr. Geo. H. Horn, of Philadelphia.

1. Cychrus (Scaphinotus) Snowi Lec. Black, without purple tinge. Head impunctured. Prothorax densely punctured, about one-third wider than long. Sides thickened and reflexed, more widely towards the base, which is strongly emarginate in an arc of a circle; tip also emarginate, but less deeply; dorsal line well impressed, transverse impressions deep, basal impressions indistinct, lost in the concavity produced by the reflexed margin. Elytra suboval, not dilated behind, lateral margin strong, wider about the humeri, which are rounded; striæ 14 or 15, distinctly impressed except the outer ones, which are confused; punctures of the striæ deep, distant a little more than their diameter. Flanks of prothorax not punctured; epipleuræ, sides of meso- and metathorax, and first ventral segments coarsely punctured. Length 9 mm.

One male. The front tarsi have the joints 1-3 moderately dilated, and spongy pubescent beneath over the whole surface, as in C. Andrewsii. This is a very singular species; the sides of the prothorax are thicker than in any other, and nearly as widely reflexed towards the base, as in C. elevatus, though the hind angles are not prolonged, nor is the humeral margin of the elytra as wide: the tarsi, as just stated, are as in C. Andrewsii, while the punctured prothorax distinguishes it at first sight from all the other species of the group. Collected in Santa Fe canon, New Mexico, (altitude, 7,000 feet,) by the Kansas University Scientific Expedition for 1880.

2. Platynus nivalis Horn. Slender, elongate, piceous, moderately shining. Head narrow, eyes not prominent. Antennæ nearly half as long as the body. Thorax elongate oval, narrower at base, sides in front arcuate, posteriorly slightly sinuate, hind angles obtuse but distinct, margin narrowly reflexed, disc slightly convex, median line moderately impressed, basal impressions feeble and with the lateral margin slightly punctured. Elytra elongate oval, humeri rounded, apex sinuate, suture at tip slightly

dehiscent, sides with narrow reflexed margin, disc feebly convex, moderately deeply striate, striæ finely crenately punctured, intervals slightly convex. Anterior tibiæ with terminal spur stouter than the upper, the tarsus without median groove on the upper side. Length .50 inch; 12.5 mm.

This species belongs to Le Conte's group A., (Bull. Brookl. Ent. Soc. II., p. 45,) and should be placed after jejunus Lec., from which it differs more especially in the deep and punctured elytrial striæ. It forms a lead toward hypolithus by this character. One specimen, female, collected by Prof. F. H. Snow, in Santa Fe canon, New Mexico, at an elevation of 7,000 feet.

3. Platynus sulcipennis Horn. Moderately elongate, piceous, shining, surface with very faint bronze lustre. Head oval, nearly as wide as the thorax. Antennæ piceous, two basal joints paler, longer than half the body. Thorax cordate, a little longer than wide, sides moderately arcuate, base narrower than apex, hind angles rectangular, margin very narrow, wider at base and nearly vertically reflected, median groove deep, basal margin punctulate, disc moderately convex and smooth. Elytra oval, humeri rounded, sutural angles obtuse, disc deeply striate, striæ distinctly punctured in the basal region, the punctures gradually finer to tip, intervals flat, the third with three dorsal punctures. Body beneath smooth; legs pale testaceous, the apical third of the femora, and sometimes the posterior tibiæ, piceous. Length, .28 in., 7 mm.

This is one of the most remarkable species in our fauna. Its general form recalls that of Anchus pusillus, while the deep and rather broad striæ, with flat intervals, give it an aspect peculiarly its own. The hind angles are rectangular and rather long, and the margin there is almost vertically reflexed. The basal impressions are therefore long and linear. The tarsi are all grooved at the sides, and there is no medial dorsal groove.

The species should be placed in Le Conte's group C., near æneolus and quadratus.

Occurs in Florida. Collected by Albert Koebele, and given me by Mr. F. G. Schaupp.

4. Elmis concolor Lec. Blackish-piceous, antennæ, tibiæ and tarsi dark testaceous. Head finely and densely punctured. Prothorax as finely but less densely punctured, without striæ; not longer than the basal width, gradually narrowed from base to tip, sides straight; base margined, oblique each side, and very obtusely angulated at the middle; all the angles are acute. Scutel smooth, triangular, finely margined. Elytra with moderately impressed, punctured striæ, interspaces feebly punctulate and very finely pubescent. Length, 4 mm.

One specimen. Related to E. vittatus and bivittatus, but stouter, and without a trace of yellow elytral stripes.

Collected in Santa Fe canon, New Mexico, by the Kansas University Scientific Expedition for 1880.

5. Onthophagus coproides Horn. Broadly oval, convex, black, polished. Clypeus nearly semi-circular, vaguely emarginate at middle, separated from the front by a slight ridge in the line of the suture, surface transversely wrinkled. Front coarsely punctate. Vertex with a strongly elevated transverse ridge arcuate to the front at middle and on each end

elevated into a sharp angle or short horn. Thorax broader than the elytra, anteriorly retuse, the vertical portion evenly punctured at middle and sparsely punctured in the concave spaces at the side, disc of thorax moderately densely punctured at middle in front, very obsoletely posteriorly, or almost smooth along the base. Elytra broader than long, each with seven feebly impressed, obsoletely punctured striæ, the outer sinuous; intervals slightly convex, sparsely obsoletely punctulate. Prothorax beneath at sides, and metasternum at sides, coarsely punctate, each abdominal segment with a row of fine punctures. Anterior tibiæ tridentate. Length, .40-.50 inch; 10-12.5 mm.

The three specimens before me are males, which vary in the development of the cephalic ridges. The anterior tibial spur is arcuate at tip. This is the largest species known in our fauna, as well as the only one with a polished surface. The mentum is acutely emarginate in front. The general resemblance of this species to a small Copris carolina has suggested the name.

Collected in Santa Fe canon, New Mexico (altitude 7,000 feet), by the Kansas University Scientific Expedition for 1880.

6. Onthophagus brevifrons Horn. Oval, slightly oblong, robust, convex. Head and thorax more shining, varying in color from bluish to violet or greenish metallic. Clypeus short and broad, very obtuse in front, the margin broadly reflexed, surface coarsely not densely punctured, suture indistinct. Front more densely and finely punctured. Vertex with a feebly-elevated transverse sinuous ridge. Thorax very little wider than the elytra, anteriorly retuse, and concave at the sides, surface coarsely but sparsely punctured, with finer punctures intermixed, more densely punctured at the middle of the protuberance. Elytra broader than long, finely seven-striate, the striæ obsoletely distantly punctulate, the outer stria arcuate, intervals flat, irregularly biseriately punctulate, each puncture with a short, erect hair; surface opaque, finely granulate, and with slight purple lustre. Body beneath sparsely punctate, abdomen with few finer punctures at the sides. Anterior tibiæ quadridentate, the upper tooth smaller. Length, .40 inch; 10 mm. Of this species I have seen four males. It resembles Janus, but is larger, more elongate, thorax more retuse in front, and with a differently formed clypeus and cephalic ornamentation.

Collected by Dr. H. A. Brous on the plains of Kansas, also in Texas.

7. O. cribricollis Horn. Oval, dark bronze, feebly shining, surface sparsely clothed with short erect hairs. Head with two transverse carinæ the one in the frontal suture, the posterior between the eyes. Clypeus coarsely punctured, anteriorly deeply emarginate, on each side triangularly dentate, front coarsely punctured. Thorax broad, coarsely, moderately shining, surface coarsely and deeply but not densely punctate. Elytra finely striate, intervals irregularly and rather densely biseriately punctate. Body beneath smoother than above, very sparsely coarsely punctate. Anterior tibiæ quadridentate. Length .14-.18 inches; 3.5-4.5 mm. This species belongs in the group with tuberculifrons and pennsylvanicus in which the sexes do not differ in the form of the thorax. The clypeus is more decidedly dentate than in the first species, but it differs from both by the transverse ridges on the head and the very coarsely punctured thorax, resembling in this respect some of the forms of Janus.

Collected by Prof. F. H. Snow in Douglas county, Kansas; occurs also in Texas.

8. Rhyssemus cælatus Lec. Brown, nearly black. Antennæ and palpi yellow. Head slightly emarginate in front, covered with granules, vertex with two oblique lines nearly meeting, and a slight elevation in front of them. Prothorax slightly wider than long, sides straight, margined; hind angles and base rounded, the latter distinctly margined; disc verrucose, with four transverse grooves, of which the first and second are entire; the third is the widest and deepest, and is expanded at the middle into a triangular impression, which divides the two posterior elevated ridges. Elytra oblong, feebly rounded on the sides, striæ double, catenately punctured, interspaces with two rows of small granules. Length 2.5 mm. One specimen. Resembles Rh. riparius Horn, but the second transverse groove of the prothorax is entire.

Collected in Santa Fe canon, New Mexico, by the Kansas University Scientific Expedition for 1880; also found by Mr. E. A. Schwartz, at Cheyenne, Wyoming.

9. Rhyssemus sonatus Lec. Black, opaque. Head and prothorax finely and densely granulate, the former convex, without ridges; emarginate in front, as usual, with the angles well defined; prothorax one-half wider than long; sides broadly rounded, margined, narrowed and subsinuate near the base, which is broadly rounded and not margined; transverse grooves very feeble, the first and second entire, the third and fourth connected with a very slight dorsal channel. Elytra oblong, scarcely rounded on the sides; striæ double and catenately punctured, as usual; interspaces narrow, subcostate, each with two series of granules. Very distinct by the obsolete impressions of the prothorax, which are very much less apparent than in Rh. Californicus.

One specimen was found by Mr. A. Bolter, near Chicago.

10. Lebasiella discoidea Lec. Head, prothorax, antennæ and legs bright ferrugineous; discoidal spot of prothorax black, club of antennæ, knees, and ends of tarsal joints blackish; elytra blue, densely and strongly punctured; under surface of trunk and abdomen black. Length 5.5 mm.

One specimen, collected in Santa Fe canon, New Mexico, by the Kansas University Scientific Expedition for 1880. Resembles L. maculicollis, but differs by the head, legs and part of antennæ being ferruginous, and by the elytra more densely punctured.

11. Pristoscelis comatus Lec. Elongate, black, with a leaden lustre, clothed with long erect hairs. Head strongly not densely punctured, antennæ with the fourth, sixth, and eighth joints a little wider than the adjoining ones, last joint longer, slender and acute at tip. Prothorax not wider than the head and eyes, very little wider than long, convex, rounded on the sides, which are not serrate; disc strongly not densely punctured. Elytra punctured as strongly but a little more densely than the prothorax. Claws with the appendage acute, one-third shorter than the claw. Length 4 mm. One specimen. Does not resemble any other species in my collection.

Collected in Santa Fe canon, New Mexico, by the Kansas University Scientific Expedition for 1880.

DOUGLAS COUNTY ADDITIONS TO THE LIST OF KANSAS COLEOPTERA IN 1879 AND 1880.

By Prof. F. H. Snow, of the University of Kansas.

Of the 144 species included in the following list, 132 were collected in the immediate vicinity of Lawrence, in Douglas county; 10 were taken by Mr. T. B. Ashton, at Tonganoxie, in Leavenworth county, only 13 miles from Lawrence; and 2 were taken in western Kansas. The locality is stated in case of each species not found in Douglas county. These additions increase the list of Kansas Coleoptera to a total of 1855 species, which is the largest list yet published from any State in the Union. In presenting these additions, I desire to recognize the invaluable services of the students in my Zoölogy classes, who have searched the country in all directions for material with which to enrich their own entomological collections, and have invariably allowed me to retain for the University cabinets all species new to the Kansas list. The following students have been especially successful in obtaining new species: Louis L. Dyche, Richard Foster, John E. McCurdy, Frank Prentiss, and Ed. G. Smith.

To Drs. Le Conte and Horn I am indebted for the determination of many of the species.

322. Zuphium americanum Dej. Taken by Mr. T. B. Ashton, in Leavenworth county.
342. Loxopeza tricolor Say.
371. Tetragonoderus fasciatus Hald.
506. Platynus lutelentus Lec. Leavenworth county—T. B. Ashton.
609. Pterostichus protensus Lec.
733a. Diplochila major Lec.
798. Anatrichis minuta Dej.
1267. Hydrocanthus iricolor Say.
1600. Hoplandria lateralis Mels.
1617. Homalota lividipennis Mann.
—— Aleochara rufipennis (?). Doubtfully referred to this European species by Dr. Le Conte.
1743. Acylophorus flavicollis Sachse.
1744. Acylophorus pronus Er.
—— Philonthus sordidus Fauv. Ms.
1859. Leptacinus longicollis Lec.
1938. Stenus femoratus Say.
1983. Bledius emarginatus Say.
2010. Geodromicus caesus Er.
2208. Ptomaphagus consobrinus Lec.
2318. Sacium fasciatum Say.
2320. Sacium lunatum Lec.
2532. Anthrenus musæorum Linn.
2461. Mycetophagus bipustulatus Mels.
2470. Litargus infulatus Lec.
2523. Mycotretus saguinipennis Say.
2616. Bitoma planicollis Lec.
2712. Brachypterus urticæ Fab.
2720. Conotelus obscurus Er.
2767. Meligethes ruficornis Lec.
2781. Amphicrossus ciliatus Ol.
2786. Cryptarcha strigata Fab.
2787. Cryptarcha liturata Lec.
2872. Exochomus marginipennis Lec. Taken also in Leavenworth county, by T. B. Ashton.
2873. Exochomus contristatus Muls.
2878. Brachyacantha 4-punctata Mels.
2930. Scymnus nanus Lec.
2937. Nosodendron unicolor Say.
—— Cistelid—Genus and species undescribed.
3081. Hister coarctatus Lec.
3188. Bacanius punctiformis Lec.
3219. Canthon praticola Lec. Wallace county.
—— Onthophagus brevifrons Horn n. sp. Western Kansas, taken by Dr. H. A. Brous. See discriptions of this and the next species by Dr. Horn in another article in this volume.
—— Onthophagus cribricollis Horn n. sp.
3392. Trox laticollis Lec.
3415. Dichelonycha elongata Fab.
3675. Valgus squamiger Beauv. Leavenworth county—T. B. Ashton.

Mr. Geo. D. Hulst, of Brooklyn, N. Y., which completes the list of new species of Noctuidæ taken at Idaho Springs, Colorado, by the Kansas University Scientific Expedition of 1879.

Catocala pura n. sp.

Expands three inches. Head gray; palpi gray, black on tips; thorax gray, collar and tegulæ edged with indistinct shading; body gray, with a brownish tinge; anal tuft lighter. Fore wings with ground color very light, giving much the same general appearance as Semirelicta; surface squamose; markings generally indistinct. Base a little more darkly marked, making an indistinct basal dash; subreniform closed; t. p. line with the two main dentations spreading and not largely produced, the lower especially, and with the dentations beneath these somewhat exaggerated, giving an irregularly-serrated appearance; submarginal line quite distinct, and against the white surface color showing very clearly its serrations; fringe gray. Hind wings red as in Briseis, median band as in Californica, but narrower, and prolonged hardly more than two-thirds across the wing; fringe pure white. There is no shading of red on the outer edge or the apex of the wing. Underneath the wings are much as in Californica, but with the median band narrowed, and ending posteriorly in a round bulb.

DESCRIPTION OF A NEW SPECIES OF CHRYSOPHANUS.

By W. H. Edwards, Coalburgh, West Va.

C. Snowi.

Male: Expands 1.2 inch.

Upper side copper-red, very nearly the hue of C. Americana; and as in that species, having the hind margins of all wings broadly fuscous; costa of primaries fuscous, primaries have a transverse discal of six or seven small black spots or points, four of which are in an oblique straight line from costa to median; the others a little within this line in the median interspaces; at the end of cell a long black spot, and a second, minute, at one-third the distance from arc to base.

Secondaries have a slightly sinuous discal row of similar spots, and between this and the margin on posterior half of the wing are indistinct fuscous spots.

Under side of primaries reddish-ochraceous on disk, gray over costal and hind margins and at base; a submarginal row of small fuscous spots; the discal row repeated, a little enlarged; the spots in cell repeated, the one on arc made up of two confluent round spots.

Secondaries gray with a reddish tint, the base and inner margin dusted black, a submarginal row of small black spots, the one next to anal angle largest, and nearly covered with orange, the next two a little dusted orange;

behind each of these three is a black point; the discal spots repeated; in cell three spots, and two on costal margin.

Female: Expands 1.25 inch.

Color lighter, more yellowish; margins bordered as in male; all spots as in male, but larger; two spots at end of cell on secondaries.

Under side as in male, but there is a third spot in cell of primaries near base; on secondaries there are three distinct spots in line across basal area, and three parallel to these a little beyond, besides two at end of cell—in all eight spots within the discal row.

From two males and one female, taken by Prof. F. H. Snow, above timber line on Gray's Peak, Colorado.

This species is nearest Cupreus Edw., but differs in several respects, and partakes of the character of some other American species. It is larger than Cupreus (known to me only from Oregon and California). The color of male is almost same as in Americana, and in the broad marginal borders there is another point of resemblance; the spots are disposed nearly as in Cupreus, but the rows are less regular; so too the color of under side is like Cupreus, but the spots are not edged buff, and instead of a complete series of orange spots across secondaries within the margin (much as in Americana, only here the spots are confluent), Snowi has a series of black spots, one only being almost concealed by orange.

LIST OF COLEOPTERA COLLECTED IN SANTA FE CANON, NEW MEXICO.

By the Kansas University Expedition For 1880.

By. Prof. F. H. Snow.

The camp in the vicinity of which the 237 species of Coleoptera in the following list were collected was situated eight miles from the city of Santa Fe, at an elevation of 7,000 feet above the level of the sea. The party was in the field for four weeks, from August 6th to September 3d, and consisted of the family of the writer, together with Mr. Louis L. Dyche and Miss Annie E. Mozley—students of the University of Kansas. My son and daughter, Willie and Mattie, eleven and ten years of age, obtained several species not collected by the other members of the party. Among the new species discovered was a large and polished Onthophagus, of which Dr. Le Conte writes that it is "the most extraordinary addition to our fauna discovered for a long time." Three specimens were obtained of the rare and curious Amphizoa Le Contei, a species which had not previously been detected within the limits of the United States.

Drs. Le Conte and Horn, to whom I am indebted for many favors in the determination of species, have kindly furnished descriptions of that portion

3691. Dicerca pugionata Germ.
3814. Agrilus Lecontei Saund.
3832. Agrilus obolinus Lec.
3850. Throscus Chevrolati Bonv.
3853. Throscus sericeus Lec.
3965. Horistonotus curiatus Say.
4091. Monocrepidius bellus Say.
4137. Melanotus clandestinus Er.
4161. Melanotus dubius Lec.
4176. Limonius auripilis Say.
4326. Corymbites inflatus Say.
4405. Helodes thoracica Guer.
4421. Dictyoptera perfaceta Say.
4405a. Photinus lacustris Lec.
4451. Photinus flavicollis Lec.
4454. Photinus decipiens Harr.
4468. Photinus punctulatus Lec.
—— Photinus—not described.
4555. Telephorus limbatus Lec.
4564. Tytthonyx erythrocephalus Fabr.
4585. Collops(near) histrio Er.
—— Anthocomus sp.
4653. Pristoscelis erythropus Lec.
4715. Priocera castanea Newm.
4723. Clerus quadrisignatus Say. Leavenworth county—T. B. Ashton.
4724. Clerus analis Lec.
4756. Hydnocera pubescens Lec.
—— Orthopleura sp.
4794. Lymexylon seriseum Harr.
4847. Zyletinus fucatus Lec.
5108. Cyllene lutosus Lec.
5159. Necydalis mellitus Say. Taken by T. B. Ashton, in Leavenworth county.
5289. Leptura vittata Germ. T. B. Ashton, Leavenworth county.
5325. Monohammus confusor Kirby. Taken by Frank Prentiss, in the Baptist church where repairs had been made with pine lumber.
5335. Goes pulcher Hald. Taken from cherry trees by John McCurdy and Willie Spencer.
5366. Lepturges facetus Say. Leavenworth county, T. B. Ashton.
—— Hyperplatys sp.
5491. Bruchus bisignatus Horn.
5494. Bruchus distinguendus Horn.
5502. Bruchus mixtus Horn.
5527. Donacia cuprea Kirby.
5662. Cryptocephalus pallidicornia Suffr.
—— Cryptocephalus vacuus Lec. Ms.
8518. Pachybrachys turbidus Lec.
8552. Disonycha rufa Ill.
—— Graptodera fuscoænea Mels.
5913. Dibolia aerea Mels.
5915. Systena frontalis Fab.
—— Ceratalitica forticornis.
5955. Stenispa collaris Baly. Leavenworth county, T. B. Ashton.
5959. Odontota scutellaris Oliv.
5960. Odontota bicolor Oliv.
6269. Echocerus maxillosus Fabr.
6448. Macratria confusa Lec.
6450. Notoxus anchora Hentz.
6462. Notoxus bicolor Say.
6486. Anthicus confusus Lec.
6603. Mordella insulata Lec.
6651. Mordellistena pubescens Fabr.
6860. Asclera excavata Lec.
—— Trachyphloeus, not named.
8742. Pterocolus ovatus Fab.
8800. Phyxelis rigidus Say.
8920. Listronotus appendiculatus Boh.
8988. Erycus morio Mannh.
9003. Pachytychius amoenus Say.
9008. Smicronyx obtectus Lec.
9038. Lissorrhoptrus simplex Say.
9072. Magdalis olyra Hbst.
9096. Anthonomus rufipennis Lec.
—— Anthonomus, not named.
9147. Tychius aratror Gyll.
9158. Gymnatron teter Fabr.
9159. Miarus hispidulus Lec.
9165. Conotrachelus albicinctus Lec.
9200. Chalcodermus collaris Horn.
9232. Phyrdenus undatus Lec.
9258. Copturus quercus Say.
9274. Coeliodes asper Lec.
9281. Ceutorhynchus rapæ Gyll.
9296. Ceutorhynchus Zimmermanni Gyll.
9297. Ceutorhynchus puberulus Lec.
9309. Rhoptobaris canescens Lec.
—— Baris n. sp.
9325. Baris insterstialis Say.
9340. Pseudobaris nigrina Say.
9360. Centrinus penicellus Hbst.
9364. Centrinus punctirostris Lec.
9371. Centrinus perscitus Hbst.
9373. Centrinus griseus Lec.
9394. Barilepton filiforme Lec.
9406. Balaninus caryæ Horn.
9451. Sphenophorus compressirostris Say.
9548. Xyleborus cælatus Eich.
—— Micracis unknown species.
9601. Phlæotribus frontalis Fab.
9653. Allandrus bifasciatus Lec. Leavenworth county—T. B. Ashton.
9662. Piezocorynus moestus Lec.

IRRIGATION IN KANSAS.

By F. G. Adams.

The subject of irrigation is not a new one. Nor is it essentially a scientific subject. The oldest nations of history practiced irrigation; and, in the earliest periods, by methods involving no scientific knowledge. A simple ditch made to turn the water of a brook, and carry it to a level above the adjacent land, whereby it can be spread over, to moisten the cultivated soil of the fields, in the season of crop growing, involves all that is essential to irrigation. Yet where irrigation is done on a larger scale, and broad and deep channels are made, hundreds of miles in length, requiring the construction of aqueducts and bridges and tunnels and reservoirs, at vast expense, and after that a just apportionment of whole rivers of water thus to be brought into use, in its application to thousands of acres of land, and among many thousands of people—in all this, much of science must needs be employed. So in the sinking of wells to great depths, to obtain water for irrigation, scientific investigation is requisite to determine the position of strata, and the reasonable sources of the water supply which is sought. The climatic effects which may accompany the change of the soil, in a district where rainfall is slight, from a state of sterility to one of great productiveness, may be a subject of no little scientific interest.

Is irrigation practicable in Kansas? This is a question which it would seem the facts of science might have long ago helped to solve. If the question has already been solved without such aid, doubtless science may be made to help in carrying forward the work which has been begun without its intervention.

Mr. Gannett's tables of elevations, together with the tables of distances on the Atchison, Topeka & Santa Fe Railroad, show the fall in the waters of the Arkansas river, between Hutchinson and the Kansas State line, to be about eight feet to the mile.

The application of the engineer's level through fifteen miles in Sequoyah county, the third county from the western line of the State, on the Arkansas river, shows the fall in the river there to be about seven and a half feet to the mile. At low stages the river banks are about four feet above the water in the channel; and the bottom lands spread out for miles from the river, at a little more than the same elevation. As the water falls, in the course of the river eastward, so does the adjacent bottom land, seven or eight feet to the mile, through several counties here, perhaps the entire distance from Hutchinson to the west line of the State, and beyond; the uplands, too, have about the same general declivity to the eastward.

In the Arkansas river, four miles above Garden City, in Sequoyah county, and about seventy-five miles from the western line of the State of Kansas, is an island, a mile or more in length, and it comes so near the northern bank of the river that at a point three-fourths of a mile below the upper

end of the island the channel between the island and the main land is but about twenty feet wide. At this point, last February or March, some gentlemen, among whom were Messrs. Landis & Hollinger, of Sterling, and Mr. W. H. Armentrout, of Garden City, under the name of "The Garden City Irrigating Company," threw across this channel a dam of brush-wood and earth. By this means they raised the water in this channed above the dam to the height of nearly five feet, or almost up to the top of the river bank. Here they commenced to dig a ditch eight feet wide and two feet deep. They made the ditch to gradually recede from the river, as they extended it out across the bottom land, so as to run, at the farthest, a mile or two from the river. The ditch is ten miles long.

It was late in June, almost July, before the ditch was so far completed as that water could be used in the irrigation of fields adjacent to it; but, as late as it was, sufficient advantage was derived to crops to bring good results, and the promise of the successful irrigation of large tracts of land in the Arkansas valley, and even on the uplands. In the experiments tried, nothing like fair tests were made, except in a few instances, and that principally in garden patches.

The persons engaged in this experiment did not go about their work with a view of making, in this year's trial, accurate proofs of results; hence no exact evidence appears to be obtainable as to how much of any crop was grown to the acre. Onions and turnips of very large size were still (last week) standing in patches, from which many of the larger, or of earlier growth, had been gathered and sold. Out on the "Great American Desert," turnips sell at $1.25 per bushel, and the temptation to gather and sell, as they became large enough, was of course irresistible. Potatoes of the finest quality and size were being dug, in fields where the stand is very scattering, from the fact that the seed had dried up and the germ perished before the ground received the water so that they could germinate. There are fields of very scattering corn, of good growth and fair-sized ears, which was planted on sod, late in June. There is abundant testimony to the fact that a patch of sweet potatoes, the plants for which were raised in the open ground, with no hot-bed of any sort, and which were set out in July, yielded nearly a thousand bushels to the acre. The statement is, that there was a little more than an acre of ground, and but little less than a thousand bushels of potatoes. There was no real measurement of the ground on which this extraordinary crop was grown, and no account was kept of the number of bushels dug and sold. They sold at $2.50 per bushel, and the money was the main object. The owner of this crop, and of most of the crops irrigated, was away in New Mexico most of the summer, looking after gold mines. He was the only man in the settlement who knew anything by experiment of the modes of the application of water in irrigation; and on his farm, the irrigation was done in quite a hap-hazard manner. In no respect has any pains been taken, by the persons engaged in the enterprise, to prove how much irrigation would produce. But the main point has been established—that is, that water, in sufficient quantities for irrigation, and at moderate cost, can be taken from the Arkansas river by ditches, and carried to fields in the bottom lands, in the valley of that river.

The mode of using the water on the farm of Mr. Worrel, was what is called bed-work irrigation. The land is gently-sloping bottom land. It is

laid off in large beds, running in the direction of the slope. The beds are separated by shallow ditches. Skirting the upper end of the entire plat, embracing all the beds, is a main ditch. If it is desired to flood the upper part of any bed, and not the whole of it at once, a furrow is run across the lower end of the portion to be flooded, making a ridge to check the water. Then the water is let from the main ditch of the plat, at the upper end, and the whole of this portion is allowed to become covered with water. Then the water may be allowed to escape into the side ditches, or the supply being cut off, to soak into the ground; or it may be let into another section of the bed, to be in its turn irrigated. On such nearly level land the process is extremely simple, and the work is easily performed.

In the digging of this ditch no engineering was done. The ditch was started a short distance, and water let run in, to see if it would run. Then another portion was dug and tried. Of course a mistake could hardly be made in judging where to run the ditch; having only the main object, and not the best selection, in view. The uniform declivity of the Arkansas river bottom renders it extremely easy to obtain a fall after the water is once brought out upon the bottom land. There are believed to be about six thousand acres of land that can be reached by water from this ditch. An interesting question is, how much land has the ditch actual capacity to irrigate? If the owners proceed upon the plan employed in locating the ditch, that of trial and experience merely, they may meet with disappointment and loss; but doubtless they will in this matter consult the experience of irrigation elsewhere.

Taking the rules of hydraulic engineering as a guide for calculation, and supposing this ditch to have a fall of three feet per mile and a twelve-foot volume of water, its capacity is 153,420 cubic feet of water per hour.

From a lengthy paper on irrigation, in the United States Agricultural Report for 1860, I have been enabled to obtain information for comparison of the Kansas experiments with works of irrigation in other countries.

In the south of France, in Italy and Algeria, where irrigation has long been very extensively practiced, the season of irrigation is, at the maximum, six months; that is, from the first of May to the end of October. Experience has there evolved at least general rules for the computation of the capacity of irrigating canals of various sizes, and the quantity of water required for irrigation; and many other practical matters, the result of long experience and careful observation, have been determined. As to the required quantity of water, the rule is, one litre of continuous water per second for every hectare: that is, fifty cubic feet of water per hour for one acre of ground, taking the season of irrigation through. The Garden City ditch, then, with a capacity of 153,420 feet per hour, will, by the French rule, irrigate 3,068 acres, or about one-half the area of ground within the reach of the ditch. But this ditch can be easily increased to a size necessary to meet any demand that may be made upon it.

The Garden City experiment has naturally enough excited the interest of the people generally in the section of the upper Arkansas valley, and other canals are already projected. One other has been begun, and will be ready to supply water for irrigation early next spring. This is also by a chartered organization called the "Kansas Irrigating, Water Power and Manufacturing Company." Of this company, Mr. C. J. Jones, of Garden

City, was the originator and is the active manager, as he has also been most active in attracting public attention to this practical development of irrigation in Kansas. The canal of this company commences at the west line of Sequoyah county, twelve miles west of Garden City. Its length is about twenty miles. It is already opened for fifteen miles—that is, it is so far made that water has been run through it for that distance. It is to be twenty-two feet wide, and will run four feet of water in depth. The cost of making it is to be not to exceed $250 per mile. Not a cut or a fill is required for the entire distance of twenty miles. The ditching is done by machinery—that is, by plowing and grading machines constructed for railroad grading and canal excavation. This canal was carefully located by a civil engineer. It has a fall of three feet to the mile. It runs clear out on the upland. It is by no means a straight canal; it has many curves, in order to keep the proper level, or rather declivity; but this winding and twisting will perhaps prove no drawback as to its utility when in use. In commencing it, advantage was taken of a time when the ground had been softened by rain for some inches, and a grading plow was run the whole distance on both sides of the contemplated ditch, making two shallow ditches, some six feet wide, leaving a strip within yet untouched. Water has been let into these shallow ditches, testing the correctness of the engineering, and removing all possibility of difficult excavation in the completion of the canal, by reason of dry and hard ground. The earth yet to be excavated can now, at any time, be softened up by sending a flow of water from the river through the shallow preliminary ditches. As remarked by Mr. Jones, "the company has got the heels of this ditch." As may well be supposed, the ground in that region is a little dry and hard at times, especially on the uplands.

The area estimated to be in reach of this canal is 38,000 acres. Applying the French rule before mentioned, its actual capacity for irrigation is about 21,600 acres. It can be easily enlarged at any time.

It is one of the most favorable circumstances connected with this irrigation undertaking in the Arkansas valley, that the cost of construction of the canal is remarkably light, compared with what must be the cost in Colorado, New Mexico, and other mountainous districts. The Garden City canal probably cost considerably more than $100 per mile. But it was made without machinery; and a number of depressions were crossed, requiring considerable filling, which would not have been necessary had its course been laid with skill. As has been said, the canal of the "Kansas Irrigating, Water Power and Manufacturing Company" is being made at a cost of $250 per mile; and this is twenty-two feet wide and four feet deep, while that of the Garden City Company is but eight feet wide and two feet deep.

The Calusa canal, in Piedmont, Italy, is twenty miles long, as is to be the Kansas canal, and the capacity is about the same, the Calusa canal being eighteen feet broad at the bottom, twenty-six feet at the surface of the water, and having a depth of three and a half feet. Its capacity is the irrigation of 18,000 acres. That of the Kansas canal is to be 21,600 acres. The Calusa canal cost $8,500 per mile. In this statement of its cost, however, there appears to be included that of fifty-nine bridges, twenty-six aqueducts and two tunnels. In the cost of the Kansas canal—$250 per mile—no

account is taken of any such accessories. The future may develop the necessity of bringing some of these things into the estimates.

In the Arkansas valley, too, the labor of irrigation, of attending the fields and conducting the water upon crops, must be far less than in hilly districts. Owing to the flatness of the land, large areas can be much more quickly and completely flooded than where the land is more sloping.

The area of land irrigated, or rather partially irrigated, in Sequoyah county the present year, did not exceed 100 acres. There are several thousand acres now plowed and ready for irrigation within the reach of the ditches, which will afford water early next spring; the price of water fixed by the irrigation companies is one dollar per acre for the year, the water to be brought by the ditch-owners to the farms of those to be furnished with it.

The spring rise in the Arkansas begins from the first to the middle of May. The river keeps up high until September or October. It is lowest through the winter and early in the spring. It is the observation of those who have become interested in these irrigation experiments, that there is seldom less than five hundred cubic feet of water in the channel and within reach of the irrigation canals in the upper counties in the Arkansas valley in Kansas. Last April, at Garden City, for four or five days, there was less than that volume, owing to a strong south wind prevailing for that time. But through the season of irrigation a much larger volume of water flows through that portion of the river.

At some distance below Sequoyah county the water sometimes disappears, and is not seen at all above the sandy bed of the river. This occurred last spring, as far up as at a point thirty miles below Garden City. But last spring being a time of general drouth in Colorado and New Mexico, the Arkansas river was unusually low. Yet it may well be supposed that no very correct observations or calculations have been made as to the amount of water the Arkansas river will afford for irrigation. The great breadth of channel and usually shallow current will render correct estimates of the quantity of water flowing within a given time quite difficult.

That there is a large area of land, in these upper counties, within comparatively easy reach of the water of the Arkansas river, there is now no question. Mr. Jones, whose opinion is worthy of great credit, estimates the area in Sequoyah county alone to be 256,000 acres. This area under irrigation and cultivation would afford sustenance to a very large population; especially taking into acount the facilities for manufacturing, which will at the same time be afforded.

Should there be any question as to the fertility of the soil to be irrigated in the Arkansas valley, that is at once set at rest by the fact that the waters with which the fields are to be flooded contain the highest elements of fertility. They are charged with the washings of a thousand hill and mountain-sides, and are thick with vegetable sediment; from that which, settled upon the land, makes a slimy paste, to the decaying and crumbling twig of the mountain pine, as large as the little finger. Such deposits are now strewn over a hundred acres of land in Sequoyah county. No one can make an examination of the irrigation begun there without bringing some of it away on his boots.

Alluding again to irrigation in other countries, in the hilly region of Piedmont not less than 2,500 cubic feet of water per second are rendered

available for irrigation, and the extent watered is 180,000 acres. The whole irrigated region of Piedmont is 1,500,000 acres; the amount of cultivated land is 890,454 acres; the total of actually irrigated land is 306,613 acres.

The total quantity of water utilized in Piedmont is 8,290 cubic feet per second, and the area is covered by a network of canals more than 1,200 miles long. The Cavo Morocca canal, in Lombardy, is 150 miles long, and its cost was $8,000 per mile. The total superficial irrigated region here is 2,500 square miles, or 1,750,000 acres. The slopes range from about 5 to 12 feet a mile. More than 27,000 cubic feet of water are discharged per second. The irrigating season commences in March and terminates in September. The months when the water is in the greatest demand are May, June, July, and August. The average annual fall of rain is given as 37 inches, of which 28 inches fall during the seven irrigating months.

The sum of the statement of irrigation for Lombardy, is a total area of 6,500,000 acres in the irrigated district, of which there are irrigated in summer, 1,061,292 acres; in winter, 12,837 acres; in all, 1,074,129 acres; or about one-sixth of the whole, or one-fifth of the productive area. The great Government canals in Lombardy are 133 miles long. Besides the main lines there are 353 branches, and probably a network of 3,550 miles. East of the Addy they reach 700 or 800 miles, thus making the entire length of the canals of Lombardy 4,500 miles. The discharge of water amounts to 15,118 cubic feet per second, while the whole amount of the discharge of rivers, etc., is 30,000 feet per second. In the entire valley of the Po, Piedmont and Lombardy, there is an extent of irrigation of 1,600,000 acres, or nearly 24,000 cubic feet per second. This view of the canals of Piedmont and Lombardy will serve to show to what a wide extent irrigation is carried on it Italy.

Irrigation is nowhere conducted on so grand a scale as in British India. Some of the canals are like mighty rivers, and a vast extent of country receives the benefit of their waters for agricultural purposes. The first canal dates back to the fourteenth century. The principal canals in India are those of the river Jumna west, of the Eastern Jumna, of the Sutlej, and of the Ganges. The whole length of the main lines of the Western Jumna canal is 445 miles. The total area of the country traversed is 3,784,385 acres. Of this, the irrigated portion is 859,902 acres. The Eastern Jumna has a system of distribution canals measuring 500 miles. The area of the land so watered is 160,000 acres.

Irrigation is extensively carried on in many countries. It is carried on in countries where the need of it and the facilities for it are less than is now apparent in western Kansas. It has been the chief purpose of this paper to call attention to experiments in irrigation in Kansas—experiments which give a promise of good results towards a permanent settlement and cultivation of considerable portions of that part of Kansas over which a doubt, to say the least, has hitherto hung. It seems that it would be worthy the employment by the State of engineering science to determine how far there is, in the Arkansas river and its branches, and in the Smoky Hill and Republican and their branches, a water supply which can be employed in irrigation, and how far such water can be turned into reservoirs upon uplands, to be utilized in manufacturing as well as irrigation. It does not seem improbable

that such work done would pay back to the State many-fold its cost. A scientific survey has long been needed for Kansas, and here is another reason why it should not be delayed.

KANSAS WEATHER SERVICE.

By Prof. J. T. Lovewell, Washburn College, Topeka.

Meteorology has been raised to the dignity of a science by virtue of combined systems of observation over vast areas, corresponding in some degree with the magnitude of the phenomena they undertake to interpret. It has come to be recognized that the problems of meteorology are vast enough to tax the energies and resources of nations; hence, in modern times the foremost governments of the earth have established weather bureaus, and provided a regular system for collecting the facts and arranging them in such a form that scientific deductions and discussions become possible.

Owing to geographical and topographical conditions, as well as to the enterprise of our meteorologists, it has been reserved for the United States to develop the most complete and accurate system of weather observation the world has yet seen. The system, however, is in its infancy, and splendid as have been the achievements of Reed, Maury, Meyer and others, much yet remains to be done to bring it to full development.

There are always to be found in every community willing observers of the weather. It is a subject which concerns everybody; it is the grand piece de resistance on which we fall back when other topics of conversation fail. It affords endless opportunities for guessing and infinite variety in treatment. It is by no means certain that scientific knowledge will in any wise improve the weather as a social theme, for by the methods of science we have nothing to conjecture which can be ascertained by actual observation, and the wise man will remain discreetly silent where knowledge fails. We can, however, afford to sacrifice the poetry of weather and its myths for the sake of truth, and there is a way of utilizing the universal interest in the subject so as to obtain a multitude of willing observers of weather phenomena, each of whom will help in establishing the basis of fact out of which all valuable theories grow and on which they rest.

This organization of volunteer work has been most successfully shown to be possible, by the labors of Hinrichs in Iowa and Nipher in Missouri, while the New York Herald Weather Department has shown what a great metropolitan newspaper can accomplish.

Here in Kansas, we have quite a number of points where meteorological notes have been accurately and systematically kept for quite a number of years. Foremost among these are Professor Snow's valuable observations at the State University, and the Signal Service observations at Leavenworth and Fort Dodge. There are many other points in the State where observa-

tions are taken occasionally, with commendable accuracy, but their value is lost from lack of continuity and system. Most observers grow tired of the monotonous record of daily weather changes, and do not perceive the value and interest of such records when long continued and systematically arranged. Even then it requires the comparison and compilation of many such records, taken at points suitably distributed throughout the State, to be able to understand their real significance and importance.

Last winter, it was resolved by the Topeka Scientific Club to try to systematize and utilize volunteer weather observations heretofore taken in Kansas, and at the same time to establish observations in every county of the State. For this purpose they organized the Kansas Weather Service. It was thought best, if possible, to enlist the combined talent of the State in the enterprise, and secure at least the sympathy, if not the active coöperation, of the U. S. Signal Service. Correspondence was accordingly entered into with the authorities at Washington, which resulted in the loan of necessary instruments for the central station. This was located at Washburn college, and the President and other officers of this institution have given very material assistance in carrying out these plans. A commodious observatory has been secured in the college building, and the college laboratory and cabinets supplement the instrumental appliances.

The writer undertook to act as director of this weather service, and with aid of Mr. Chase and Mr. Hilton, of the Topeka Scientific Club, observers were engaged in different parts of the State, instructions and blanks were issued, and arrangements made for supplying thermometers and raingauges.

This preliminary work was completed last July, and since then a careful record has been kept at the central station, and reports published. About twenty-five other stations are now established and from some of these the reports have been sent in with considerable regularity and accuracy. There is evidence that much patience and labor are requisite to secure observations at desirable points that will be satisfactory. There exists, however, much reason for encouragement, and the work will be steadily pushed as fast as the resources at our command will allow. It must be remembered that all the labor is done without remuneration, and in time snatched from the intervals of other occupations. This is true of the director as well as all the observers, and not only must time be given freely, but expenses for printing, paper and postage must be provided. These have thus far been met by the liberality of the Scientific Club and by Washburn College. The ends to be gained are worthy all the effort, since we shall secure data for a more accurate study of the ordinary weather phenomena than has hitherto been possible. We shall also have a trained body of observers to note the facts in any occasional phenomena, like tornadoes, earthquakes, remarkable temperatures and rainfalls. There will be valuable notes on the phenomena relating to vegetation, rainfall and temperature, which cannot fail to be more accurate than any yet published, and they will be useful in determining the exact resources and advantages of different parts of the State. The question whether our rainfall increases with the cultivation of the soil, interesting alike in its scientific and economic aspects, can only be settled by such observations as we propose to publish.

Finally, when these reports are taken in connection with similar reports

of the two great contiguous States of Missouri and Iowa, their combined value will be greatly enhanced for purely scientific purposes. We shall have a larger consecutive area of the earth's surface under minute and systematic observation than exists elsewhere to my knowledge. We can trace storms in their track over a level country, from western Kansas to the Mississippi river, many hundred miles in any direction, and can thus determine their laws and the ways of avoiding them, if this be possible. At the next annual meeting of the Academy it is hoped that the organization of the Kansas Weather Service will be so far perfected that no question will exist as to its permanence. It is not, of course, expected that the fruits of its work will be gathered or apparent the first or the second year. It may be changed in many details when experience shows such changes profitable, and ultimately should be considered a permanent feature of the Agricultural Department of the State, and be under State management. The objct of bringing it at this time before the Academy, is to present its claim to scientific interest, and to secure sympathy and coöperation in a work which, if done at all, must be the labor of many hands.

METEOROLOGICAL SUMMARY.

Prof. F. H. Snow's Annual Reports as Meteorologist to the State Board of Agriculture.

Station: Lawrence, Kas. Latitude 38° 57′ 25″; longitude, 95° 15′; elevation of barometer and thermometers, 875 feet above the sea level, and 5 feet above the ground; rain-guage on the ground; anemometer, 105 feet above the ground, on the dome of the University building, 1,200 feet above the sea level.

SUMMARY FOR 1878.

The chief characteristics of the weather of 1878 were the large and well-distributed rainfall, the high average temperature, the absence of great extremes of temperature, the long period of immunity from severe frosts, the comparative lightness of the winds, and low temperature and great snowfall of the month of December.

TEMPERATURE.

Mean temperature of the year, 55.33°, which is 2.37° above the mean of the ten preceding years. The highest temperature was 98°, on the 15th of July and 24th of August; the lowest was 6° below zero, on the 18th and 25th of December, giving a yearly range of 104°. Mean temperature at 7 a. m., 49.46°; at 2 p. m., 64.32°; at 9 p. m., 55.31°.

Mean temperature of the winter months, 32.41°, which is 2.79° above the average winter temperature; of the spring, 57.37°, which is 4.58° above the average; of the summer, 75.13°, which is 1.2° below the average; of the autumn, 56.13°, which is 3.87° above the average.

The coldest month of the year was December, with a mean temperature of 23.05°; the coldest week was December 21st to 27th, with mean temperature, 11.18°; the coldest day was December 24th, with mean temperature, 4.3°. The mercury fell below zero seven times, all of which were in December.

The warmest month of the year was July, with a mean temperature of 78.45°; the warmest week was July 10th to 16th, with mean temperature, 83.90°; the warmest day was July 14th, with mean temperature, 85.6°. The mercury reached or exceeded 90° on 35 days, viz.: 15 in July, 14 in August, and 6 in September.

The last light frost of spring was on May 14th; the first frost of autumn was on October 18th, giving an interval of 157 days entirely without frost. The last severe frost of spring was on March 4; the first severe frost of autumn was on October 18th, giving an interval of fully seven months, or 228 days, without severe frost. No frost or cold weather during the year caused any damage to fruit or fruit buds.

RAIN.

The entire amount of rain, including melted snow, was 38.39 inches, which is 3.48 inches above the average annual amount for the ten preceding years. Either rain or snow fell on 107 days. The longest interval without rain during the growing season, (March 1st to October 1st,) was 12 days, July 8th to 20th. The number of thunder showers was 38. These occurred in all months of the year except November and December. There were three light hail storms.

SNOW.

The entire depth of snow was 25½ inches, of which 2½ inches fell in February, 1 inch in October, 2 inches in November, and 20 inches in December. The last snow of spring was on March 29th; the first snow of autumn was on October 26th. The single storm of December 12th and 13th brought 14 inches of snow—this being the greatest snowfall on our eleven years' record.

FACE OF THE SKY.

The average cloudiness of the year was 40.65 per cent., which is 4.52 per cent. below the average. The number of clear days (less than one-third cloudy) was 190; half-clear days (from one-third to two-thirds cloudy), 93; cloudy (more than two-thirds), 82. There were 59 entirely clear, and 37 entirely cloudy days. The clearest month was August, with an average cloudiness of 19.19 per cent.; the cloudiest month was February, with an average of 54.63 per cent. The mean cloudiness as 7 a. m. was 47.32 per cent.; at 2 p. m., 44.99 per cent.; at 9 p. m., 29.66 per cent

DIRECTION OF THE WIND.

During the year, three observations daily, the wind was from the N. W. 327 times; S. W., 281 times; S. E., 134 times; N. E., 136 times; E., 60 times; S., 55 times; N., 53 times; W., 28 times; calm, 21 times. The north

wind (including northwest, north and northeast) outnumbered the south winds (including southwest, south and southeast), in the ratio of 516 to 470.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 125,793, which is 16,078 miles less than the average annual distance for the past six years. This gives a mean daily velocity of 344.47 miles, and an average hourly velocity of 14.34 miles. The highest hourly velocity was 60 miles, on April 9th; the highest daily velocity was 919 miles, on March 8th; the highest monthly velocity was 15,106, in October. The three windiest months were March , May and October; the three calmest months were February, July and August. The average hourly velocity of the wind at 7 a. m. was 13.44 miles; at 2 p. m., 16.39 miles; at 9 p. m., 14.07 miles.

BAROMETER.

Mean height of the barometer, 29.067 inches; mean at 7 a. m., 29.090 inches; at 2 p. m., 29.047 inches; 9 p. m., 29.063 inches. Maximum, 29.735 inches, on December 24th; minimum, 28.335, on April 9th; yearly range, 1.400 inches. The highest monthly mean was 29.268 inches, in December; the lowest was 28.851 inches, in April. The barometer observations are corrected for temperature and instrumental error.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 70.4; at 7 p. m., 81.26; at 2 p. m., 50.82; at 9 p. m., 77.22. The dampest month was July, with mean humidity, 78.27; the driest month was November, with mean humidity, 62.60. There were only five fogs during the year. The lowest humidity for any single observation was 18.2, on November 23d.

The following table gives the mean temperature, the extremes of temperature, the velocity of the wind, the percentage of cloudiness, the relative humidity, and the rainfall, for each month of the year 1878.

MONTHS.	Mean temperature.	Maximum temperature.	Minimum temperature.	Miles of wind.	Mean cloudiness.	Relative humidity.	Rainfall, inches.
January	33.97	55.0	7.5	9,996	47.42	73.40	3.05
February	40.22	66.0	15.5	7,393	54.63	76.50	2.86
March	50.90	81.0	27.0	11,994	40.86	67.64	2.67
April	58.60	82.0	36.0	11,482	38.22	66.03	5.48
May	62.60	85.0	38.5	12,207	52.90	70.90	5.66
June	69.79	89.0	50.0	9,187	48.66	74.80	5.67
July	78.48	98.0	58.0	7,974	31.29	78.27	4.30
August	77.14	98.0	56.0	8,188	19.19	74.60	2.22
September	67.58	94.5	41.0	11,972	30.66	66.40	2.51
October	55.55	87.0	20.0	15,106	28.92	63.70	0.44
November	45.87	72.0	22.0	11,198	42.00	62.60	1.55
December	23.05	53.0	—6.0	9,096	55.75	65.70	1.98

SUMMARY FOR THE YEAR 1879.

The chief characteristics of the weather of 1879 were the high average temperature of the spring and autumn months, the long period of immunity from severe frost, the deficient rainfall of March, May and August, the extraordinary rainfall of November, and the low percentage of cloudiness. It is worthy of note that, notwithstanding the deficiency of rain in the months above named, the crops have been abundant in all the agricultural sections of the State.

TEMPERATURE.

Mean temperature of the year, 54.67°, which is 1.51° above the mean of the eleven preceding years. The highest temperature was 99.5°, on August 4th; the lowest was 16° below zero, on the 4th of January—giving a yearly range of 115.5°. Mean temperature at 7 a. m., 48.61°; at 2 p. m., 63.71°; at 9 p. m., 53.18°.

Mean temperature of the winter months, 27.93°, which is 1.94° below the average winter temperature; of the spring, 58.04°, which is 4.83° above the average; of the summer, 76.05°, which is .47° below the average; of the autumn, 56.71°, which is 3.90° above the average.

The coldest month of the year was January, with mean temperature, 23.49°; the coldest week was January 2d to 8th, with mean temperature, 3.90°; the coldest day was January 3d, with mean temperature, 9.3° below zero. The mercury fell below zero 13 times, of which 10 were in January and 3 in December.

The warmest month was July, with mean temperature 79.14°; the warmest week was July 5th to 11th, with mean temperature 83.54°; the warmest day was July 22d, with mean temperature, 86.9°. The mercury reached or exceeded 90° on 48 days, viz.: 4 in May, 12 in June, 16 in July, 14 in August, and 2 in September.

The last light frost of spring was on April 18th; the first light frost of autumn was on October 19th—giving an interval of 184 days entirely without frost. The last severe frost of spring was on April 4th; the first severe frost of autumn was on October 24th—giving an interval of nearly seven months, (203 days,) without severe frost. The severe cold weather of January and the frost of April 3d were very destructive to the buds of peaches, pears and early apples in many localities, but there was generally a fair crop of small fruit and winter apples.

RAIN.

The entire amount of rain, including melted snow, was 32.68 inches, which is 2.70 inches below the average annual amount for the eleven preceding years. Either rain or snow fell on 90 days, 12 less than the average. The longest interval without rain, during the growing season, (March 1st to October 1st,) was 19 days, from April 30th to May 19th. The number of thunder showers was 36, of which 9 were in June and 1 in December. There were 5 light hail storms.

SNOW.

The entire depth of snow was 10.35 inches, of which .85 inch fell in

January, 4.51 inches in February, 2 inches in November, and 3 inches in December. The last snow of spring was on February 23d; the first snow of autumn was on November 28th.

FACE OF THE SKY.

The average cloudiness of the year was 40.1 per cent., which is 4.75 per cent. below the average. The number of clear days (less than one-third cloudy), was 179; half-clear days (from one-third to two-thirds cloudy), 114; cloudy, (more than two-thirds), 72. There were 61 entirely clear and 35 entirely cloudy days. The clearest month was August, with an average cloudiness of 28.92 per cent.; the cloudiest month was December, with an average of 51.83 per cent. The mean cloudiness at 7 a. m. was 44.09 per cent; at 2 p. m., 46.27 per cent; at 9 p. m., 29.67 per cent.

DIRECTION OF WIND.

During the year, three observations daily, the wind was from the S. W. 272 times, N. W. 238 times, S. E. 158 times, S. 130 times, N. E. 112 times, E. 90 times, N. 71 times, W. 16 times, calm 8 times. The south winds, including southwest, south, and southeast, outnumbered the north winds, including northwest, north, and northeast, in the ratio of 560 to 421.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 124,768, which is 14,160 miles less than the average for the past six years. This gives a mean daily velocity of 341.83 miles, and a mean hourly velocity of 14.24 miles. The highest hourly velocity was 60 miles, on Februray 25th and March 18th; the highest daily velocity was 960 miles, on March 8th; the highest monthly velocity was 13,787 miles, in March. The three windiest months were March, November, and December; the three calmest months were June, July, and August. The average hourly velocity at 7 a. m. was 12.78 miles; at 2 p. m., 16.29 miles; at 9. p. m., 14.03 miles.

BAROMETER.

Mean height of barometer column, 29.127 inches; at 7 a. m., 29.150 in.; at 2 p. m., 29.103 in.; at 9 p. m., 29,126 in.; maximum, 29.745 in., on January 3d; minimum, 28.534 in., on December 28th; yearly range, 1.211 in. The highest monthly mean was 29.253 in., in January; the lowest was 29.024 in., in May. The barometer observations are corrected for temperature and instrumental error.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 67.13; at 7 a. m., 77.86; at 2 p. m., 50.11; at 9 p. m., 73.41. The dampest month was January —mean humidity 76; the driest month was March—mean humidity 56.1. There were 10 fogs during the year. The lowest humidity for any single observation was 12.3, at 2 p. m., on March 9th—less than one-eighth of saturation.

In presenting this report, the writer desires to acknowledge his in-

debtedness to Prof. H. S. S. Smith, for taking the observations during seven weeks' absence in the summer vacation.

The following table gives the mean temperature, the extremes of temperature, the velocity of the wind, the per cent. of cloudiness, the relative humidity, and the rainfall, for each month of the year 1879:

MONTHS.	Mean temperature.	Maximum temperature.	Minimum temperature.	Miles of wind.	Mean cloudiness.	Relative humidity.	Rainfall, inches.
January	23.49	53.0	—16.0	8,309	43.98	76.0	0.37
February	34.06	74.0	5.0	10,097	39.04	64.7	0.41
March	48.22	87.0	11.0	13,787	46.02	56.1	0.37
April	56.40	84.0	20.0	11,231	49.67	61.0	4.18
May	69.50	93.0	43.0	12,057	37.20	60.9	1.60
June	73.22	97.0	45.0	9,498	41.33	69.9	7.14
July	79.14	97.5	62.5	6,980	34.89	73.8	3.66
August	75.78	99.5	49.0	6,815	28.92	63.8	1.03
September	65.40	92.0	42.0	10,237	37.00	64.0	3.57
October	60.46	87.5	25.5	10.952	31.94	71.2	2.81
November	44.26	76.5	16.0	11,964	38.33	70.6	5.15
December	26.23	65.5	—9.0	12,821	51.83	74.0	2.39
Mean	54.67	83.8	24.5	10,397	40.01	67.1	2.72

SUMMARY FOR THE YEAR 1880.

The year 1880 surpassed all previous years of our record in the warmth of its January, the coldness of its November, its maximum monthly and hourly velocity of wind, and the earliness of its spring and winter. Maples were in blossom February 11th, and the genuine winter weather began November 11th, continuing without interruption to the end of the year.

The temperature, wind velocity and relative humidity were above, while the fall of rain and snow and the cloudiness were below, the annual averages.

The most remarkable meteorological event of the year was the wind storm of March 27th, which filled the air to a great height with an almost impalpable dust, and obscured the sun during the entire day after 10 a. m.

TEMPERATURE.

Mean temperature of the year, 54.01°, which is .72° above the mean of the twelve preceding years. The highest temperature was 101°, on August 18th; the lowest was 12° below zero, on the 29th of December, giving a yearly range of 113°. Mean at 7 a. m., 48.10°; at 2 p. m., 66.55°; at 9 p. m., 52.20°.

Mean temperature of the winter months, 34.88°, which is 5.17° above the average winter temperature; of the spring, 56.63°, which is .33° below the average; of the summer, 74.92°, which is 1.60° below the average; of the autumn, 49.56°, which is 3.58° below the average.

The coldest month of the year was December, with mean temperature, 25.84°; the coldest week was December 25th to 31st, with mean temperature, 9.41°; the coldest day was December 28th, with mean temperature 2.7°

below zero. The mercury fell below zero only twice during the year, on December 28th and 29th.

The warmest month was July, with mean temperature 75.75°; the warmest week was August 13th to 19th, with mean temperature 82.61°; the warmest day was August 18th, with mean temperature 86°. The mercury reached or exceeded 90° on 41 days, viz: 1 in April, 7 in May, 8 in June, 13 in July, and 12 in August.

The last light frost of spring was on April 30th; the first light frost of autumn was on September 13th, giving an interval of 136 days (nearly 5 months) entirely without frost. The last severe frost of spring was on March 20th; the first severe frost of autumn was on October 17th, giving an interval of 211 days (nearly 7 months) without severe frost. No frost or cold weather during the year did any damage to fruit buds or trees. Both large and small fruits were produced abundantly.

RAIN.

The entire amount of rain, including melted snow, was 32.65 inches, which is 2.34 below the average annual amount for the 12 preceding years. Either rain or snow fell on 89 days—12 less than the average. On 11 of these days the quantity was too small for measurement. The longest interval without rain during the growing season (March 1st to October 1st) was 18 days—from August 2d to 19th. The number of thunder showers was 29. There were 4 light hail storms, all of which occurred in March, April and May.

SNOW.

The entire depth of snow was 7 inches, which is about one-third of the average. Of this amount, 3 inches fell in March, 2½ inches in November, and 1½ inches in December. The last snow of spring was on March 15th; the first snow of autumn was on November 16th.

FACE OF THE SKY.

The average cloudiness of the year was 40.15 per cent., which is 4.18 per cent. below the average. The number of clear days (less than one-third cloudy) was 196; half-clear days (from one-third to two-thirds cloudy), 87; cloudy (more than two-thirds), 83. There were 65 days on which the cloudiness averaged .8 or more. There were 51 entirely clear, and 33 entirely cloudy days. The clearest month was February, with an average cloudiness of 24.94 per cent.; the cloudiest month was December, with an average of 54.08 per cent. The mean cloudiness at 7 a. m. was 44.79 per cent.; at 2 p. m., 44.20 per cent.; at 9 p. m., 31.48 per cent.

DIRECTION OF WIND.

During the year, three observations daily, the wind was from the S. W. 324 times; N. W.., 242 times; S. E., 158 times; S., 113 times; N. E., 107 times; E., 61 times; N., 55 times; W., 37 times; calm, once. The south winds (including southwest, south and southeast) outnumbered the north winds (including northwest, north and northeast) in the ratio of 595 to 404.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 146,039,

which is 9,154 miles above the annual average for the seven preceding years. This gives a mean daily velocity of 399.01 miles, and a mean hourly velocity of 16.62 miles. The highest velocity was at the rate of 80 miles an hour, from 3:30 to 3:45 a. m., on April 18th. The highest daily velocity was 1,121 miles, on March 27th and April 18th; the highest monthly velocity was 16,709 miles, in April. The three windiest months were March, April and May; the three calmest months were July, August and September. The average hourly velocity at 7 a. m. was 15.30 miles; at 2 p. m., 18.44 miles; at 9 p, m., 15.70 miles.

BAROMETER.

Mean height of barometer column, 29.123 inches; at 7 a. m., 29.148 inches; at 2 p. m., 29.099 inches; at 9 p. m., 29.123 inches; maximum, 29,791 inches, on November 21st; minimum, 28.303 inches, on April 18th; yearly range, 1.488 inches. The highest monthly mean was 29.295 inches, in November; the lowest was 29.019 inches, in May. The barometer observations are corrected for temperature and instrumental error.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 67.9; at 7 a. m., 79.2; at 2 p. m., 49.9; at 9 p. m., 74.6. The dampest month was December—mean humidity, 76.5; the driest month was April—mean humidity, 53.4. There were 18 fogs, of which 9 were in January, and 4 in December. The lowest humidity for any single observation was 11.8, at 2 p .m. on April 14th—less than one-eighth of saturation.

The following tables give the mean temperature, the extremes of temperature, the velocity of the wind, the per cent. of cloudiness, the relative humidity, the rainfall (including melted snow), and the depth of snow, for each month of the year 1880, and a comparison with the twelve preceding years:

1880.	Mean temperature.	Maximum temperature.	Minimum temperature.	Miles of wind.	Mean cloudiness.	Relative humidity.	Rainfall, inches.	Snow, inches.
January	41.23	67.0	20.5	12,861	48.49	73.8	1.80	0.0
February	37.58	69.0	8.0	11,861	24.94	64.5	0.73	0.0
March	42.38	79.0	2.5	13,841	44.94	63.4	2.03	3.0
April	56.92	93.0	31.0	16,709	34.56	53.4	1.75	0.0
May	70.59	94.0	52.0	14,108	40.43	62.6	4.11	0.0
June	73.57	96.0	50.5	12,629	37.00	68.1	4.10	0.0
July	75.75	98.0	54.0	9,312	28.23	68.3	2.34	0.0
August	75.45	101.0	50.5	8,863	45.70	70.8	7.93	0.0
September	64.59	85.0	42.0	10,124	32.00	73.2	2.46	0.0
October	52.52	81.0	28.0	12,745	39.24	66.3	2.73	0.0
November	31.58	65.5	7.5	11,325	51.77	74.4	2.24	2.5
December	25.84	61.0	—12.0	11,661	54.08	76.5	0.43	1.5
Mean	54.01	82.5	27.9	12,169	40.15	67.9	2.72	0.6

Comparison with previous years:

YEARS.	Mean temperature.	Maximum temperature.	Minimum temperature.	Miles of wind.	Mean cloudiness.	Relative humidity.	Rainfall, inches.	Snow, inches.	Rainy days.
1868	53.36	101.0	*—16.5	——	42.35	——	37.42	27.50	77
1869	50.99	96.0	—5.0	——	49.23	——	38.51	18.00	105
1870	54.50	102.0	—10.0	——	47.88	68.4	31.38	9.50	100
1871	54.30	103.0	—6.0	——	47.37	——	32.23	29.75	120
1872	51.90	97.0	—18.0	——	44.33	64.4	32.63	23.25	116
1873	52.71	104.0	—26.0	154,508	42.46	64.0	32.94	26.50	101
1874	54.20	108.0	—3.0	145,865	45.54	65.5	28.87	43.00	99
1875	50.60	99.0	—16.5	145,316	44.81	65.5	28.87	5.00	106
1876	52.76	98.0	—5.0	148,120	41.27	66.8	44.18	24.75	102
1877	54.16	99.0	—9.0	113,967	47.12	72.6	41.09	15.50	126
1878	55.33	98.0	—6.0	125,793	40.65	70.4	38.39	25.50	107
1879	54.67	99.5	—16.0	124,768	40.01	67.1	32.68	10.35	90
1880	54.01	101.0	—12.0	146,039	40.15	67.9	32.65	7.00	89
Mean, 13 years	53.34	100.4	—13.0	138,047	44.09	67.2	34.83	20.43	103

*The minus sign denotes temperature below zero.

PRELIMINARY LIST OF THE HYMENOPTERA OF KANSAS.

By Prof. F. H. Snow, University of Kansas.

The following species of Hymenoptera have been incidentally collected by the writer and his students, during the summer vacations of the past ten years, while chiefly engaged in making collections of Lepidoptera and Coleoptera. The list might have been considerably enlarged by including species known to have been taken in Kansas by Eastern collectors. But it has been thought best to include only those species which are contained in the University cabinets, the locality of whose capture is exactly known. The extreme eastern and western portions of the State have contributed the material here designated. The species from Douglas county were taken in the immediate vicinity of the city of Lawrence, at an elevation of nearly 1,000 feet above the level of the sea. The species from Wallace county were taken at various camping places on the so-called "Plains," at an elevation of about 3,500 feet.

I am greatly indebted to Mr. E. T. Cresson, of Philadelphia, for valuable aid in the determination of the species.

It is hoped that this neglected order of insects may in the future receive a larger share of attention from Kansas entomologists, not only with a view to enlarging the list of species, but especially for the purpose of increasing our knowledge of their habits.

APIDÆ: BEES.

Apis mellifica Linn. Douglas county.
Bombus Pennsylvanicus DeGeer. Douglas and Wallace counties.
Bombus separatus Cresson. Douglas county.
Emphor bombiformis Cresson. Douglas county.
Apathus elatus Fab. Douglas county.
Anthidium maculifrons Sm. Wallace and Gove counties.
Anthidium notatum Latr. Douglas county.
Anthidium concinnum Cr. Wallace county.
Anthophora Smithii Cr. Wallace county.
Anthophora Walshii. Douglas county.
Anthophora occidentalis Cr. Wallace county.
Didasia enavata Cr. Wallace county.
Melissodes albata Cr. Douglas and Wallace counties.
Melissodes confusa Cr. Wallace county.
Melissodes menuachus Cr. Douglas and Wallace counties.
Melissodes pruinosa Say. Douglas and Wallace counties.
Melissodes densa Cr. Wallace county.
Melissodes australis Cr. Wallace county.
Melissodes aurigenia Cr. Wallace county.
Melissodes Coloradensis Cr. Wallace county.
Melissodes obliqua Say. Douglas and Wallace counties.
Melissodes n. sp. Douglas county.
Melissodes rustica Cr. Douglas county.
Melissodes binotata Say. Douglas county.
Melissodes condigna Cr.
Melecta interrupta Cr. Douglas and Wallace counties.
Cœlioxys dubitata Sm.
Cœlioxys octo-dentata Say. Douglas county.
Cœlioxys n. sp. Douglas county.
Cœlioxys deplanata Cr.
Epeolus occidentalis Cr. Wallace county.
Epeolus fumipennis Say. Wallace county.
Epeolus lunatus Say. Douglas county.
Epeolus remigatus Fabr. Douglas and Wallace counties.
Epeolus lectus Cr.
Megachile bucephala Sm.
Megachile femorata Sm. Douglas county.
Megachile acuta Sm. Douglas county.
Megachile lanuginosa Sm. Douglas county.
Megachile latimanus Say. Wallace county.
Megachile pruina Sm. Wallace county.
Megachile brevis Say.
Megachile fortis Cr.
Megachile deflexa Cress.
Megachile Sayi Cress.
Nomada zebrata Cr.
Nomada electa Cr.
Nomada accepta Cr.
Panurgus marginatus Cr.

ANDRENIDÆ.

Andrena maculifrons Cr. Wallace county.
Nomia Nortoni Cr. Douglas county.
Nomia n. sp. Douglas county.
Eunomia marginipennis Cr. Wallace county.
Agapostemon tricolor St. Farg. Douglas county.
Agapostemon Texanus Cr. Douglas and Wallace counties.
Augochlora fervida Sm. Douglas county.
Augochlora pura Say.
Halictus occidentalis Cr. Douglas and Wallace counties.
Halictus Sp. Douglas county.
Sphecodes Sp. Wallace county.
Sphecodes dichroa Sm. Wallace county.
Colletes n. sp. Douglas county.

VESPIDÆ: WASPS.

Vespa maculata L. Douglas county.
Vespa diabolica Sauss. Douglas county.
Polistes fuscatus Fab. Douglas county.
Polistes fuscatus var. pallipes St. Farg. Douglas county.
Polistes variatus Cr. Douglas and Wallace counties.
Polistes rubiginosus St. Farg. Douglas county.

EUMENIDÆ.

Pterochilus 5-fasciatus Say. Douglas and Wallace counties.
Odynerus annulatus Say. Wallace county.
Odynerus arvensis Sauss. Douglass and Wallace counties.
Odynerus anormis Say. Douglas and Wallace counties.
Odynerus quadrisectus Say. Douglas county.
Odynerus foraminatus Sauss. Douglas and Wallace counties.
Odynerus campestris Sauss. Douglas county.
Odynerus unifasciatus Sauss. Douglas county.
Odynerus tigris Sauss. Wallace county.
Monobia quadridens Linn. Douglas county.
Eumenes Bollii Cr. Douglas county.
Eumenes Smithii Sauss. Douglas county.
Eumenes fraterna Say. Wallace county.

CRABRONIDÆ: WOOD WASPS.

Cerceris venator Cr. Wallace county.
Cerceris bicornuta Guerin. Douglas county.
Cerceris compacta Cr. Douglas county.
Cerceris clypeata Dahl. Douglas county.
Cerceris deserta Say. Douglas county.
Eucerceris canaliculatus Say. Wallace county.
Philanthus punctatus Say. Douglas county.
Philanthus ventilabris Fab. Wallace county.
Crabro Packardii Cr. Wallace county.

Trypoxylon clavatum Say. Douglas county.
Trypoxylon n. sp. Wallace county.

NYSSONIDÆ.

Gorytes rufoluteus Packd. Douglas county.
Nysson Texanus Cr. Wallace county.
Larra unicincta Say. Douglas and Wallace counties.
Larra abdominalis Say. Wallace county.
Stizus brevipennis Walsh. Douglas county.
Stizus speciosus Drury. Douglas and Wallac counties.
Stizus grandis Say. Wallace county.
Stizus nevadensis Cr. Wallace county.

BEMBECIDÆ.

Monedula obliqua Cr. Wallace county.
Monedula ventralis Say. Wallace county.
Bembex fasciata Fab. Douglas and Wallace counties.
Bembex nubilipennis Cr. Douglas county.
Bembex monodonta Say. Douglas county.

LARRIDÆ.

Astata nubecula Cr. Wallace county.
Astata bicolor Say. Wallace county.
Tachytes abdominalis Say. Wallace county.
Tachytes pepticus Say. Douglas and Wallace counties.
Tachytes texanus Cr. Wallace county.
Tachytes distinctus Sm. Wallace county.
Tachytes distinctus Sm. Wallace county.
Tachytes mandibularis Patton. Wallace county.
Larrada analis Fab. Wallace county.
Larrada argentata Beauv. Douglas county.

SPHEGIDÆ: MUD WASPS.

Priononyx atrata St. Farg. Douglas county.
Sphex icheumonea Fab. Douglas and Wallace counties.
Sphex Pennsylvanica Linn. Douglas county.
Chlorion cæruleum Linn. Douglas and Wallace counties.
Pelopæus cæruleus Linn. Douglass county.
Pelopæus cementarius. Douglass county.
Ammophila gracilis St. Farg. Douglass and Wallace counties.
Ammophila Aberti Hald. Wallace county.

POMPILIDÆ.

Pepsis dubitata Cr. Douglas county.
Ceropales fraternus Sm. Wallace county.
Priocnemis terminatus Say. Wallace county.
Priocnemis flammipennis Sm. Wallace county.
Pompilus algidus Sm. Wallace county.
Pompilus maurus Cr. Douglas and Wallace counties.

Pompilus Philadelphicus St. Farg. Douglas county.
Pompilus conicus Say. Douglas county.
Pompilus fulvicornis Cr. Douglas and Wallace counties.
Pompilus interruptus Say. Wallace county.
Pompilus tropicus Fab. Wallace county.
Pompilus atrox Dahl. Douglas county.
Pompilus unifasciatus Say. Douglas county.
Pompilus ferrugineus Say. Douglas county.
Pompilus notatus Fab. Douglas county.
Pompilus formosus Say. Wallace county.

SCOLIADÆ.

Elis plumipes Drury. Douglas county.
Scolia bicincta Fab. Douglas county.
Scolia Le Contei Cr. Wallace county.
Tiphia inornata Say. Wallace and Gove counties.
Myzine hamata Say. Douglas county.
Myzine 6-cincta Fab. Douglas county.

MUTILLIDÆ: STINGING ANTS.

Mutilla creusa Cr. Wallace county.
Mutilla aureola Cr. Wallace county.
Mutilla Californica Rad. Wallace county.
Mutilla hexagona Say. Wallace county.
Mutilla brazoria Blake. Wallace county.
Mutilla occidentalis Cr. Wallace county.
Mutilla simillima Sm. Wallace county.
Mutilla propinqua Cr. Wallace county.
Mutilla fulvohirta Cr. Wallace county.
Mutilla Sayi Blake. Wallace county.
Mutilla bioculata Cr. Wallace county.
Mutilla ferrugata Fab. Wallace county.
Mutilla oajaca Blake. Wallace county.
Mutilla fenestrata St. Farg. Douglas and Wallace counties.
Agama glabrella Cr. Wallace county.
Agama clara Cress. Douglas county.
Mimosa (Myrmosa?) unicolor Say. Douglas county.

CHRYSIDIDÆ.

Chrysis parvula Fab. Wallace county.
Chrysis sp. Douglas county.

INCHEUMONIDÆ: ICHNEUMONS.

Pelecinus polycerator Drury. Douglas county.
Thyreodon n. sp. Douglas county.
Ophion purgatus Say. Douglas county.
Toxoneuron seminigrum Cr. Wallace county.

Thalessa lunator Fabr. Douglas county.
Thalessa atrata Fabr. Douglas county.
Undetermined gen. and sp. Douglas county.
Trogus exesorius Brullé. Douglas county.
Trogus obsidianator Br. Douglas county.
Ichneumon longulus Cr. Douglas county.
Icheumon w-album Cr. Douglas county.
Ichneumon laetus Br. Douglas county.
Ichneumon devinctus Say. Wallace county.
Ichneumon vittefrons Cr. Douglas county.
Ichneumon viola Cr. Douglas county.
Ichneumon cincticornis Cr. Wallace county.
Ichneumon grandis Br. Douglas county.

TENTHREDINIDÆ.

Tremex columba Fab. Douglas county.
Cimbex Americana Peck. Douglas county.

FORMICARIÆ: ANTS.

Formica sp. Douglas county.
Camponotus sp. Douglas county.

ADDITIONS TO THE LIST OF KANSAS LEPIDOPTERA.

By Prof. F. H. Snow, University of Kansas.

In vol. IV. of the Transactions of this Academy (1875), the writer published a "Catalogue of the Lepidoptera of Eastern Kansas," giving brief descriptions of 503 species and mentioning their food plants as far as known. During the five years since the publication of that catalogue he has been able to add 140 species to the list, 116 of which were taken in Douglas county, within five miles of Lawrence, and about thirty miles west of the Missouri river. Fourteen species were taken in Western Kansas, in Wallace and Gove counties, by the various scientific expeditions of the Kansas University; seven were taken at Topeka, by Prof. E. A. Popenoe; two at Tonganoxie, by T. B. Ashton; and one at Columbus, by Geo. F. Gaumer. Including these additions, the Lepidoptera are classified as follows:

Diurnal Lepidoptera, or Butterflies	84
Sphingidæ, or Hawk Moths	31
Aegeridæ, or Aegerians	7

Zygaenidæ	7
Bombycidæ, or Silkworm Moths	79
Noctuidæ, or Owlet Moths	294
Phalænidæ, or Geometrids	72
Pyralidæ, or Snout Moths	52
Tortricidæ, or Leaf Rollers	10
Tineidæ, of Tineids	6
Pterophoridæ, or Plume Moths	1
Total number of species thus far catalogued	643

The additions to the previons list are as follows:

DIURNALS.

Pieris rapæ Linn. European cabbage butterfly; abundant at Lawrence since March, 1880.

Gonepteryx Lycide Godt. Lawrence; L. L. Dyche.

Thecla M-album Boisd. Columbus; Geo. F. Gaumer.

Lycæna Melissa Edw. Western Kansas, in Wallace and Gove counties.

Lycæna Acmon West.-Hew. Wallace county.

Ancyloxypha Waco Edw.

Pamphila Uncas Edw. Wallace and Gove counties.

SPHINGIDÆ.

Sesia diffinis Grote.

Aellopos Titan Cramer.

Proserpinus gauræ Sm.-Abb. Wallace county.

Sphinx Canadensis Boisd. Leavenworth county; T. B. Ashton

AEGERIADÆ.

Aegeria—three undetermined species. Wallace county.

ZYGÆNIDÆ.

Ctenucha venosa Walk.

Lycomorpha pholus Drury.

Thyris lugubris Boisd. Topeka; Prof. E. A. Popenoe.

BOMBYCIDÆ.

Cisthene subjecta Walk.

Arctia Blakei Grote.

Cerura n. sp. Wallace county.

Notodonta bilineata Pack. Topeka; Prof. E. A. Popenoe.

NOCTUIDÆ.

Acronycta occidentalis Grote.

Acronycta lobeliæ Guen.

Acronycta luteicoma G. & R.

Acronycta afflicta Grote.

Acronycta albarufa Grote.

Acronycta exilis Grote.
Acronycta sperata Grote.
Acronycta lithopila Grote.
Agrotis alternata Grote.
Agrotis incivis Guen.
Mamestra distincta Hubn.
Mamestra trifolii Esp.
Mamestra detracta Walk.
Mamestra quadrannulata Morr.
Hadena delicata Grote.
Hadena costalis Grote.
Hadena passer Guen.
Hadena stipata Morr.
Hadena versicolor Morr. Topeka, Prof. E. A. Popenoe.
Hadena arna Guen.
Prodenia flavimedia Harvey.
Prodenia lineatella Harvey.
Platysenta atriciliata Grote.
Leucania pseudargyria Guen.
Orthodes cynica Guen.
Graphiphora sp.
Glæa viatica Grote.
Lithophane ferrealis Grote.
Ingura flabella Grote n. sp.
Ingura oculatrix Guen.
Calpe Canadensis Bethune.
Hypsoropha monilis Fabr.
Phyprosopus callitrichoides Grote.
Acopa perpallida Grote—n. sp. Wallace county.
Plusia verruca Fabr. Taken "at sugar," by L. L. Dyche.
Plusia ou Guen.
Schinia trifascia Hubn.
Porrima sanguinea Geyer.
Rhododipsa volupia Fitch. Gove county.
Lygranthæcia Packardi Grote. Topeka, Prof. E .A. Popenoe.
Lygranthæcia jaguarina Grote. Wallace county.
Heliothis nuchalis Grote.—n. sp.
Tarache lactipennis Harvey. Wallace county.
Eustrotia synochitis G. & R.
Eustrotia musculosa Guen.
Lithacodia bellicula Hubn.
Xanthoptera coccineifascia Grote. Topeka, Prof. Popenoe.
Syneda Howlandii Grote. Wallace county.
Bolina versabilis Harvey.
Bolina nigrescens G. & R.
Bolina ochreipennis Harvey.
Brotis vulneraria Hubn. Wallace county.
Ctictoptera divaricata Grote.
Catocala Nebraskæ Dodge.
Catocala habilis Grote. Tonganoxie; T. B. Ashton.

Catocala Anna Grote.
Catocala Clintonii Grote.
Catocala Whitneyi Dodge.
Catocala Frederica Grote.
Allotria elonympha Hubn.
Pleonectyptera pyralis Hubn.
Remigia hexastylus Harvey.
Phurys vinculum Guen.
Phurys lima Guen.
Trama arrosa Harvey.
Eutoreuma tenuis Grote.
Pheocyma lunifera Hubn.
Homoptera penna Morr.
Pseudanthracia cornix Guen.
Spargaloma umbrifascia Grote.
Homopyralis discalis Grote.
Epizeuxis æmula Hubn.
Epizeuxis americalis Guen.
Pityolita pedipilalis Guen.
Zanclognatha ochreipennis Grote.
Zanclognatha cruralis Guen.
Renia discoloralis Guen.
Renia centralis Grote.
Renia Belfragei Grote.
Renia (?) plenilinealis Grote.
Bomolocha abalienalis Walk.

PHALÆNIDÆ.

Eupithecia miserulata Grote.
Petrophora diversilineata Hubn.
Philbalapternyx latirupta Walk.
Hetorophelps triguttata H.-S.
Stegania pustularia Guen. Wallace county.
Eois ferrugata Pack. Topeka; Prof. E. A. Popenoe.
Acidalia perirrorata Pack.
Acidalia enucleata Guen.
Paraphia subatomaria Guen.
Cymatophora humaria Guen.
Hyperetis nyssaria Guen.
Hyperetis var. amicaria H.-S.
Antepione depontanata Grote.
Endropia madusaria Walk.
Endropia bilinearia Pack.
Endropia pectinaria Guen.
Endropia obtusaria Guen.
Metanema inatomaria Guen.

PYRALIDÆ AND TINEIDÆ.

Margaritana quadristigmalis Guen.

Botis 5-linealis Grote.
Botis phœnicealis Hubn.
Botis adipaloides G. & R.
Eurycreon rantalis Guen.
Eurycreon onythesalis Walk.
Eurycreon cereralis Zeller.
Eurycreon sticticalis Linn.
Crocidophora tubercularis Led.
Scoptocnema integra Zeller.
Chilo crambidoides Grote n. sp.
Crambus lachellus Zincken.
Crambus edonis Grote n. sp.
Crambus vulvivagellus Clem.
Myelois albiplagiatella Pack. Topeka; Prof. Popenoe.
Conchylis Ridingsana Robinson. Wallace county.
Mochlocera Zelleri Grote.
Fruva tortricina Zeller.
Anaphora sp. Topeka; Prof. Popenoe.
Nola minuscula Zeller.

The writer desires to acknowledge his indebtedness to Messrs A. R. Grote and W. H. Edwards, for many favors in the determination of species. The new species of moths in this last have already been discribed by Mr. Grote in the "Canadian Entomologist."

ORNITHOLOGY OF RILEY COUNTY, KANSAS.

By Dr. C. P. Blachly, Manhattan.

I have in the following lists put down only those that I know to be here, receiving valuable aid from my friend, Prof. E. A. Popenoe, in the way of identifying birds; also from Prof. F. H. Snow. Many of my specimens have been brought in by farmer friends, and some of the hunters of Manhattan, so that I have not had the opportunity I desired to study their habits. The lists will be increased as I have opportunity, and it is safe to say that the number of species that will be found will easily exceed two hundred.

Two species have been taken that are not on Prof. Snow's catalogue, while quite a number of those marked rare have been found. Three new ones (the Great Blue Heron, King Rail and Little Black Rail) have been found breeding, and two (the Wood Pewee and White Heron) taken under circumstances such as to make it almost certain that they breed.

My list now embraces one hundred and eighty-two species, of forty-three families.

TURDIDÆ: THRUSHES AND MOCKING BIRDS.

Turdus migratorius Linn. American robin. Chiefly migratory, but is occasionally found in flocks in sheltered places during winter. It is growing more abundant each year.

Turdus mustelinus Gm. Wood thrush. Common in summer.

Turdus Swainsoni Cab. Olive-backed thrush.

Mimus polyglottus Linn. Mocking bird. Common summer resident.

Mimus Carolinensis Linn. Catbird. Common summer resident.

Harporhynchus rufus Linn. Brown thrush. Common summer resident.

SAXICOLIDÆ: BLUEBIRDS.

Sialia sialis Linn. Eastern bluebird. Abundant early in spring, and stays late in the fall. Occasional winter resident. Breeds.

SYLVIIDÆ: SYLVIAS.

Polioptila cœrulea Linn. Blue-gray gnat-catcher. Two specimens captured.

PARIDÆ: TITMICE.

Lophophanes bicolor Linn. Tufted titmouse. Inserted on the authority of Prof. A. E. Popenoe.

Parus atricapillus var. septentrionalis Harr. Common resident.

SITTIDÆ: NUTHATCHES.

Sitta Carolinensis Gm. White-bellied nuthatch. Common.

TROGLODYTIDÆ: WRENS.

Troglodytes aëdon. Vieill. House wren. Common summer resident.

Cistothorus palustris Wilson. Long-billed marsh wren.

Cistothorus stellaris Licht. Short-billed marsh wren.

TLAUDIDÆ: LARKS.

Eremophila alpestris Forst. Horned lark. Abundant; early arrivals from the north being the last of September. It is known to breed occasionally as early as March, retiring in April.

MOTACILLIDÆ: WAGTAILS.

Anthus ludovicianus Gm. Titlark. Migratory; common.

SYLVICOLIDÆ: WARBLERS.

Protonotaria citrœa Bodd. Prothonotary warbler. A single specimen taken.

Dendrœca œstiva Gm. Yellowpoll warbler. Abundant in summer.

Dendrœca coronata Linn. Yellow-rumped warbler. Seen as late as Oct. 17th, 1880.

Siurus noveboracensis Gm. Small-billed water-thrush.

Oporornis formosus Wils. Kentucky warbler. Taken the first of June.

Geothlypis trichas Linn. Maryland yellow-throat.

Icteria virens Linn. Yellow-breasted chat. Common summer resident.

Setophaga ruticilla Linn. Redstart. A young bird taken Aug. 16, 1878.

TANAGRIDÆ: TANAGERS.

Pyranga rubra Linn. Scarlet tanager. Common summer resident.

HIRUNDINIDÆ: CLIFF SWALLOWS.

Hirundo lunifrons Say. Cliff swallow. Common summer resident.

Hirundo bicolor Vieill. White-billed swallow. Common summer resident.

Cotyle riparia Linn. Bank swallow. Common summer resident.

Progne purpurea Linn. Purple martin. Abundant. Summer resident. Have a curious habit of flocking together about the tallest buildings in towns, for a few days prior to departure, leaving for the South probably in the very early morning. One seen March 17, 1881.

AMPELIDÆ: WAX-WINGS.

Ampelis garrulus Linn. Northern wax-wing. Rare. Three specimens shot from a large flock, Dec.6, 1879, by Prof. D. E. Lantz, a pair of which are now in the State University.

Ampelis cedrorum Vieill. Cedar bird. Not common; taken Dec. 4th.

Myiadestes Townsendii Aud. Townsend's fly-catching thrush. Rare; a single specimen taken.

VIREONIDÆ: GREENLETS.

Vireo olivaceus Linn. Red-eyed vireo. Summer resident; common.

Vireo Bellii Aud. Bell's vireo. Common summer resident.

Vireo gilvus Vieill. Warbling vireo. On the authority of Prof. Popnoe.

LANIIDÆ: SHRIKES.

Collyrio borealis Vieill. Butcher bird. One taken Jan. 16, 1879.

Collyrio Ludovicianus Linn. Loggerhead shrike. One taken March 15.

FRINGILLIDÆ: FLINCHES AND SPARROWS.

Ægiothus linaria Linn. Red-poll linnet. One specimen, January, 1881.

Chrysomitris tristis Linn. Yellowbird. Common resident.

Plectrophanes nivalis Linn. Snow bunting. Irregular winter visitant.

Plectrophanes lapponicus Linn. Lapland longspur. Common in winter.

Plectrophanes ornatus Towns. Chestnut-collared bunting.

Passerculus savanna Wils. Savanna sparrow. Migratory; common.

Poœcetes gramineus Gm. Grass finch; bay-winged bunting. One specimen taken about the middle of November, 1880.

Caturniculus passerinus Wils. Yellow-winged sparrow.

Melospiza Lincolni Aud. Lincoln's finch. Migratory; one taken in November, 1880.

Junco hyemalis Linn. Black snowbird. Winter resident; common.

Spizella monticola Gm. Tree sparrow. Abundant winter resident.

Spizella socialis Wils. Chipping sparrow. Common summer resident.

Spizella pallida Sw. Clay-colored sparrow. A single specimen taken.

Zonotrichia albicollis Gm. White-throated sparrow. Migratory; common.

Zonotrichia leucophrys Forst. White-crowned sparrow. Migratory; common.

Zonotrichia querula Nutt. Harris's sparrow. Migratory; common.

Passer domesticus L. English sparrow. First seen in spring of 1880. Resident.

Chondestes grammaca Say. Lark finch. Abundant in summer.

Passerella iliaca Sw. Fox sparrow.

Euspiza Americana Gm. Black-throated bunting. Abundant in summer.

Goniaphea cœrulea Linn. Blue grosbeak. Common in summer.

Cyanospiza cyanea Linn. Indigo-bird. Common summer resident.

Cardinalis Virginianus Linn. Redbird. Resident; common.

Pipilo erythrophthalmus Linn. Chewink. Summer resident; common.

Pipilo maculatus Sw. var. arcticus Sw. Artic towhee; spotted chewink, Rare migrant. One taken by Prof. E. A. Popenoe, October, 1880.

ICTERIDÆ: AMERICAN STARLINGS; BLACKBIRDS.

Dolichonyx oryzivorus Linn. Bobolink. Taken in spring.

Molothrus pecoris Gm. Cowbird. Abundant from early spring to late in fall.

Agelæus phœniceus Linn. Red-wing blackbird. Common summer resident.

Xanthocephalus icterocephalus Bp. Yellow-headed blackbird. Chiefly migratory. Abundant in spring of 1876, feeding on the Rocky Mountain locust. Seen also as late as July 4, 1878.

Sturnella magna Linn. Meadow lark. Summer resident; common. Seen also in sheltered places occasionally during winter.

Var. neglecta Aud. Western lark. Same remarks apply as to the above.

Isterus spurius Linn. Orchard oriole. Summer resident; abundant.

Icterus Baltimore Linn. Baltimore oriole. Summer resident; abundant.

Quiscalus purpureus Bart. Crow blackbird. Very abundant in summer, and in fall congregating in large flocks, and going miles to a common roosting place.

CORVIDÆ: CROWS AND JAYS.

Corvus Americanus Aud. Common crow. Resident; common.

Pica melanoleuca Vieill. Magpie. Several seen in mid-winter, near Randolph, by Geo. Dougherty, and one in July, 1880, by myself at Manhattan.

Cyanurus cristatus Linn. Blue Jay. Resident; abundant.

TYRANNIDÆ: AMERICAN FLY-CATCHERS.

Tyrannus Carolinenis Linn. Kingbird. Bee martin. Summer resident; abundant.

Myiarchus crinitus Linn. Great-crested fly-catcher. Common summer resident.

Sayornis fuscus Gm. Pewee; Phœbe-bird. Common summer resident.

Contopus virens Linn. Wood pewee. Migratory; not common. Taken in summer; probably breeds.

Empidonax obscurus Bd. Wright's fly-catcher. One specimen taken by myself and identified by Prof. E. A. Popenoe.

CAPRIMULGIDÆ: GOAT SUCKERS.

Astrostomus vociferus Wils. Whippoorwill. Rare.

Astrostomus Nuttallii Aud. Nuttall's whippoorwill. Common summer resident.

Chordeiles Virginianus Gm. Night hawk. Common summer resident.

CYPSELIDÆ: SWIFTS.

Chœtura pelagia Linn. Chimney swallow. Summer resident; common.

TROCHILIDÆ: HUMMING BIRD.

Thochilus colubris Linn. Ruby-throated humming-bird. Summer resident; common.

ALCEDINIDÆ: KINGFISHERS.

Ceryle alcyon Linn. Belted kingfisher. Summer resident; common.

CUCULIDÆ: CUCKOOS.

Coccyzus Americanus Linn. Yellow-billed cuckoo. Summer resident; common.

PICIDÆ: WOODPECKERS.

Hylotomus pileatus Linn. Black woodcock. Rare resident.

Picus villosus Linn. Hairy woodpecker. Resident; common.

Picus pubescens Linn. Downy woodpecker. Resident; common.

Centerus Carolinus Linn. Red-bellied woodpecker. Resident; common.

Melanerpes erythrocephalus Linn. Red-headed woodpecker. Summer resident; common.

Colaptes auratus Linn. Golden-winged woodpecker. Common resident.

Colaptes auratus var. hybridus Baird. Rare.

STRIGIDÆ: OWLS.

Strix flammea Linn. Barn owl. One taken October 12, 1878, is now in the State University.

Bubo Virginianus Gm. Great horned owl. Resident; common.

Scops asio Linn. Screech owl. Resident; common.

Otus Wilsonianus Less. Long-eared owl.

Brachyotus palustris Bechst. Short-eared owl.

Syrnium nebulosum Forst. Barred owl. Common.

Nyctale acadica Gm. Saw-whet owl. Rare. Taken Feb. 8, 1879.

Speotyto cunicularia Mol. Burrowing owl. Once common, but not now found in Riley county.

FALCONIDÆ: DIURNAL BIRDS OF PREY.

Cirus Hudsonius Linn. Marsh hawk. Resident; common.

Nauclerus furcatus Linn. Swallowed-tailed kite. Rare. A handsome specimen, taken the 1st of September, 1880, had lost the beak to the upper end of the cere. This had healed perfectly when captured. The bird is now in my possession.

Accipiter fuscus Gm. Sharp-shinned hawk. Migratory; common.

Astur atricapillus Wils. Goshawk. A female that had just finished eating a rabbit was captured by W. F. Allen, in February, 1878. It is now in the cabinet of the State University.

Falco sacer Forst. var. islandicus Cass. Jer-falcon. One specimen taken, fall of 1880.

Falco communis Gm. Duck hawk. Rare. One specimen taken.

Falco columbarius Linn. Pigeon hawk. Taken in December 1878.

Falco sparverius Linn. Sparrow hawk. Resident; common.

Buteo Harlani Aud. Harlan's hawk. One specimen taken.

Buteo borealis Gm. Red-tailed hawk. Common; resident. A nest of three eggs was taken by Mr. Persons, from a tree on his land. The same birds nesting again, Prof. E. A. Popenoe and myself took the two eggs, which were nearly ready to hatch.

Buteo lineatus Gm. Red-shouldered hawk.

Archibuteo lagopus Brunn. var. Sancti-Johannis Gm. Rough-legged hawk. Taken Jan. 11.

Pandion haliaëtus Linn. Fish-hawk. A fine specimen taken by Geo. W. Harrop, Oct. 14th, 1880.

Aquila chrysaëtus Linn. Golden eagle. Not uncommon in winter.

Halitaëus leucocephalus Linn. Bald eagle. Resident; rare. A fine specimen was not captured when it swooped down upon a stuffed goose (Branta Canadensis), set out on a sandbar for a decoy. The pedastal on which the goose was mounted, being covered with sand, was quite heavy, so it only overturned when struck by the talons of the eagle. The eagle then alighted for a moment by the side of the decoy, and gave it a look of unutterable surprise and disgust which was only exceeded by my own, as he spread his noble pinions and sailed away out of my sight before I could bring my gun to bear on him.

CATHARTIDÆ: VULTURES.

Cathartes aura Linn. Turkey buzzard. Common; resident.

COLUMBIDÆ: DOVES.

Zenædura Carolinensis Linn. Common dove. Summer resident; abundant. Also seen in sheltered places during the entire year.

MELEAGRIDIDÆ: TURKEYS.

Meleagris gallopavo Linn. Wild turkey. Once common; now rare.

TETRAONIDÆ: GROUSE; QUAIL.

Cupidonia cupido Linn. Prairie chicken. Resident; abundant.
Ortyx Virginianus Linn. Bob-white; quail. Resident; abundant.

CHARADRIIDÆ: PLOVERS.

Charadrius fulvus Gm. var. Virginicus Bork. Golden plover. Migratory.

Ægialitis vociferus Linn. Killdeer. plover. Summer resident; abundant; seen as late as November 7, 1880.

Ægialitis semipalmatus Bp. Ring plover. One specimen.

RECURVIROSTRIDÆ: Avocets.

Recurvirostra Americana Gm. American avocet. Migratory; not common.

PHALAROPODIDÆ: PHALAROPES.

Phalaropus Wilsoni Sab. Wilson's phalarope. Migratory; rare.

SCOLOPACIDÆ: SNIPE, CURLEW, ETC.

Gallinago Wilsoni Temm. American snipe. Migratory; common.
Macrorhamphus griseus Gm. Red-breasted snipe. Migratory.
Macrorhamphus scolopaeus Say. Long-billed snipe. Migratory; rare.
Micropalama himantopus Bp. Stilted sandpiper. Migratory; rare.
Ereunetes pusillus Linn. Semipalmated sandpiper. Migratory; rare.
Tringa minutilla Vieill. Least sandpiper; migratory; abundant.
Tringa maculata Vieill. Jack-snipe; migratory; common.
Tringa Bonapartii Schl. White-rumped sandpiper; migratory; rare.

Totanus semipalmatus Gm. Willet. Migratory; common. Two specimens taken by Master John Elliott, June 1st, 1880.

Totanus melanoleucus Gm. Greater telltale. Migratory; common.

Totanus flavipes Gm. Yellow-legs. Migratory; abundant.

Totanus solitarius Wils. Solitary tattler. Not common; probably breeds; taken August 13.

Tringoides macularius Linn. Spotted sandpiper.

Actiturus Bartramius Wils. Field-plover. Summer resident; abundant.

Tryngites rufescens Vieill. Buff-breasted sandpiper. Migratory.

Numenius longirostris Wils. Long-billed curlew. Summer resident; not uncommon; taken June 17.

Numenius borealis Forst. Esquimaux curlew. Migratory.

ARDEIDÆ: HERONS.

Ardea herodias Linn. Great blue heron. Summer resident; common. Four nests in one sycamore tree were a great temptation to me, but I could not reach them.

Ardea egretta Gm. White heron. Probably breeds, as a family were seen, of which one old one and one half grown were captured by Rev. A. B. Campbell, about the 1st of August, 1880.

Ardea virescens Linn. Green heron. Summer resident; common.

Botaurus minor Gm. Bittern; stakedriver. Summer resident; common

Ardetta exilis Gm. Least bittern. Rare.

GRUIDÆ: CRANES.

Grus Americanus Linn. White or whooping crane. Migratory; rare.

Grus Canadensis Linn. Sandhill crane. Migratory; common. Passes north about the middle of April. From a flock of four, two were shot, April 15th, one of which showed a good many white feathers on the thighs, and some on the neck.

RALLIDÆ; RAILS.

Rallus elegans Aud. King rail. Rare. A nest of eight eggs and the female were taken in May, 1880. The male was seen several days later in the same place, but was not captured.

Porzana carolina Linn. Common rail. Migratory.

Porzana Jamaicensis Gm. Little black rail. Rare. Two taken, one on Sept. 4, 1878, and one in June of 1880. Also, at same date and place as the last, a nest of eight eggs that had been washed out by high water.

Fulica Americana Gm. Coot; mud hen. Abundant; migratory. Probably breeds.

ANATIDÆ: SWANS, GEESE, AND DUCKS.

Cygnus buccinator Rich. Trumpeter swan. Migratory; rare; passes north about the 1st of March.

Anser albifrons Gm. var. Gambeli Hart. Laughing goose. Two specimens taken.

Anser hyperboreus Pall. Snow goose. Migratory; common.

Branta Canadensis Linn. Canada goose. Migratory; abundant in migration, and a rare winter resident.

Branta Hutchinsii Sw. Hutchinson's goose. Migratory; not common.

Anas boschas Linn. Mallard duck. Migratory; abundant.

Dafila acuta Linn. Pintail duck. Migratory; common.

Chaulelasmius streperus Linn. Gadwall; grey duck. Migratory common.

Mareca Americana Gm. American widgeon. Migratory; common.
Querquedula Carolinensis Gm. Green-winged teal. Migratory; abundant.
Querquedula discors Linn. Blue-winged teal. Migratory; common.
Spatula clypeata Linn. Shoveler; spoon-bill. Migratory.
Aix sponsa Linn. Summer duck. Summer resident.
Fuligula affinis Eyt. Little black-head. Common. A specimen taken with a white feather in one wing.
Fuligula Donov. Ring-necked duck. Migratory.
Aythya Americana Eyton. Red-head duck. Migratory; common.
Aythya vallisneria Wils. Canvas-back duck. Migratory; common.
Bucephala clangula Linn. Golden-eyed duck. Migratory; rare; winter resident. Two taken about the 1st of December, by Dan. Casement.
Bucephala albeola Linn. Butterball. Migratory; common.
Erismatura rubida Wils. Ruddy duck. Migratory; rare.
Mergus Merganser Linn. Merganser; goosander. Migratory.
Mergus serrator Linn. Red-breasted merganser. Migratory.
Mergus cucullatus Linn. Hooded merganser. Migratory.

PELECANIDÆ: PELICANS.

Pelecanus erythrorhynchus Gm. American Pelican. Migratory; common. Pass north about the 10th of April, in large flocks. One female was taken that had eggs developed to the size of one inch in diameter. The bill of this specimen bore a well-developed "button."

PHALACROCORACIDÆ: CORMORANTS.

Graculus dilophus Sw. Double-crested cormorant. Migratory; rare.

LARIDÆ: TERNS.

Hydrochelidon lariformis Linn. Black tern; short-tailed tern. Migratory; rare. Taken May 13, 1878.

COLYMBIDÆ: LOONS.

Colymbus torquatus Brunn. Loon. One immature specimen taken.

PODICIPIDÆ: GREBES.

Podiceps auritus Linn. var. Californicus Heerm. American eared grebe. Migratory; rare. One taken Sept. 30, 1878, is now in the Smithsonian Institution.
Podilymbus podiceps Linn. Pied-billed Grebe; dabchick. Migratory.

The following are resident:

Robin.
Black-capped tit.
White-bellied nuthatch.
American goldfinch.
English sparrow.
Redbird.
Meadow lark.
Western lark.
Crow.
Blue jay.
Black woodcock.
Hairy woodpecker.

Downy woodpecker.
Red-bellied woodpecker.
Golden-winged woodpecker.
Great horned owl.
Barred owl.
Marsh hawk.
Red-tailed hawk.
Bald eagle.
Turkey buzzard.
Dove.
Turkey.
Prairie chicken.
Quail—25.

List of specimens that breed in this county. Those marked with a * have been taken in the breeding season, but are not positively known to breed.

Robin.
Wood thrush.
Mocking bird
Catbird.
Brown thrush.
Bluebird.
House wren.
horned lark.
Yellow warbler.
Kentucky warbler.*
Maryland yellow-throat.*
Yellow-breasted chat.
Redstart.*
Scarlet tanager.
Cliff swallow.
White-bellied swallow.
Bank swallow.
Purple martin.
Red-eyed vireo.
Bell's vireo.
Yellow bird.
Yellow-winged sparrow.
Chipping sparrow.
English sparrow.
Lark finch.
Black-throated bunting.
Blue grosbeak.
Indigo bird.
Redbird.
Chewink.
Cowbird.
Red-winged blackbird.
Meadow lark.
Western lark.
Orchard oriole.
Baltimore oriole.
Crow blackbird.
Crow.
Blue jay.
King-bird.
Great-crested flycatcher.*
Wood pewee.*
Whippoorwill.*
Nuttall's whippoorwill.*
Night hawk.
Chimney swallow.
Humming bird.
Kingfisher.
Yellow-billed cuckoo.
Black woodcock.
Hairy woodpecker.
Downy woodpecker.
Red-bellied woodpecker.
Red-headed woodpecker.
Golden-winged woodpecker.
Great horned owl.
Screech owl.*
Barred owl.
Marsh hawk.
Sparrow hawk.
Red-tailed hawk.
Bald eagle.
Turkey buzzard.
Carolina dove.
Prairie chicken.
Turkey.
Quail.
Kildeer plover.
Field plover.
Solitary tattler.*
Long-billed curlew.
Great blue heron.
White heron.*
Green heron.
Bittern.
King rail.
Little black rail.
Coot.
Wood duck.
Hooded mersanger (?)*—80.

List of winter residents only. Those marked with a * are rare.

Northern waxwing.*
Butcher bird.*
Lapland longspur.
Black snow-bird.
Golden eagle.
Tree sparrow.
Harris's sparrow.—7.

A PRELIMINARY CATALOGUE OF KANSAS REPTILES AND BATRACHIANS.

By F. W. Cragin, Cambridge, Mass.

The object of this catalogue is to give a condensed view of the present state of our knowledge concerning the herpetological fauna of Kansas. As this object would not otherwise be fully accomplished, I incorporate in the list of reptiles and batrachians already observed in the State, the names of such others as cannot reasonably be doubted to occur there; and append to this a supplementary list, comprising the names of species whose future identification in Kansas there is more or less reason to anticipate, giving with each name the principal evidence upon which it is included.

Among those who have kindly assisted me in the preparation of this catalogue, I am most indebted to Prof. E. A. Popenoe, of the Kansas State Agricultural College, whose warm and constant interest in my work has been shown in a most practical manner by the sending of many notes and specimens. Acknowledgements are also due to Prof. F. H. Snow, of the Kansas State University, for the use of undetermined material in the museum of that institution, and for several interesting notes; to Prof. E. D. Cope, for the determination of difficult species and for other favors; through Prof. S. F. Baird, to Mr. S. C. Brown, of the Smithsonian Institution, for a a list of the Kansas reptiles and batrachians in the National Museum; to J. S. Nolan, of the Philadelphia Academy of Natural Science, for similar list, drawn up from the collection of said Academy; through Mr. J. A. Allen, to Mr. S. Garman, of the Cambridge Museum of Comparative Zoölogy, for a similar list of specimens under his charge, as well as for other favors; to Prof. William Wheeler, of Ottawa, for notes on the tortoises, etc., of the Osage river at that point; to Mr. Harvey Worrall, of Topeka, for the names of specimens in the collection at the State House; and to Col. N. S. Goss, of Neosho Falls.

Of the published writings which I have found useful in the study of Kansas herpetology, the most important are, Cope's "Check-list of North American Batrachia and Reptilia," (the classification and nomenclature in which are followed in the present paper;) Dr. Hallowell's writings in Proc. Phila. Acad. Nat. Sci., 1856, pp. 238 and 309; Miss A. E. Mozley's "List of Kansas Snakes in the Museum of the Kansas State University," (Transac. Kan. Acad. Sci., VI;) Agassiz's "Contributions to the Natural History of the United States," I; and Jordan's "Manual of the Vertebrates."

TESTUDINATA.

EMYDIDÆ.

Cistudo ornata Agass.: Western Box-tortoise. Appears to be rather

common at Manhattan, and westward throughout the State. Its eastern limit has not been definitely ascertained. I have observed Cistudo common at Topeka, but whether of the ornata or clausa type, I am unable to state. A young specimen of ornata, taken at Manhattan, by Prof. Popenoe, shows a slight approach to clausa, in having a partially developed keel.

Cistudo clausa Gm. Box-tortoise. Prof. Wheeler writes me that he has observed this species at Ottawa. This is doubtless nearly the western limit of its distribution.

Cistudo clausa Gm. var. triunguis Ag.: Three-toed Box-tortoise. A single specimen, observed by Prof. Popenoe, at Manhattan. Osage river (Agassiz).

Chrysemys oregonensis Harl.: Golden Tortoise. The range of this species is given by authors as extending over nearly the entire region west of the Mississippi and east of the Pacific slopes.

Chrysemys picta Herm.: Painted Tortoise. An Eastern species, but doubtless ascending the Missouri and its tributaries well into the State. Under the name of C. Bellii, Agassiz has recorded its abundance in western Missouri. Prof. Popenoe writes me that he has observed in the Kansas river a tortoise which he believes to be of this species, but not having obtained a specimen, is not quite sure.

Malacoclemmys pseudogeographicus Holb.: Le Sueur's Map-tortoise. Five specimens of this tortoise, included in Dr. Hammond's Kansas and Nebraska collection (Hallowell) were probably taken at or near Fort Riley, as were most of the specimens in this collection. Osage river (Agassiz).

Malacoclemmys geographicus Le Sueur: Map-tortoise. Prof. Wheeler, writing from Ottawa, states that he has observed the geographicus at that locality. I believe this observation somewhat extends its known westward range.

Pseudemys elegans Wied.: Elegant Terrapin. Osage river, and from the upper Missouri to Texas (Agassiz). Illinois to the Rocky Mountains (Jordan).

CINOSTERNIDÆ.

Armochelys carinatus Gray: Southern Musk-tortoise. Under the name of Ozotheca tristycha, Agassiz gives this species as common in the Osage river.

CHELYDRIDÆ.

Chelydra serpentina Linn.: Snapping-tortoise. Reported from Ottawa by Prof. Wheeler, and from Lawrence from Prof. Snow. Ranges over the entire region east of the Sierra Nevada and south of British America to Ecuador. (Cope).

TRIONYCHIDÆ.

Aspidonectes spinifer Le Sueur: Soft-shelled Tortoise. Prof. Popenoe writes me that he has taken three specimens of this tortoise at the mouth of the Blue river. Prof. Wheeler also reports it from Ottawa, and Prof. Snow from Lawrence. Authors mention it as common in most of the tributaries of the Missouri.

Amyda mutica Le Sueur: Leathery Tortoise. This species is not uncommon in the vicinity of Manhattan, where Prof. Popenoe has observed it in the Blue and Kansas rivers.

LACERTILIA.

IGUANIDÆ.

Phrynosoma douglassii Bell: Horned Lizard. Three specimens taken at Fort Riley, by Dr. Hammond (Hallowell). Prof. Snow informs me that he has taken douglassii in Douglas county, and knows of its having been taken in Doniphan county. Specimens from Kansas are in the National Museum (Brown), and in the collection of the Philadelphia Academy (Nolan).

Phrynosoma cornutum Harl.: Texan Horned Lizard. This appears to be, generally, the commoner Phrynosoma of Kansas. It occurs at least as far east as Ottawa, where it has been taken by Prof. Wheeler. Four specimens sent from Manhattan, by Prof. Popenoe, vary considerably in color, and have the inferior surface of the body marked with sparse black spots, but offer no marked peculiarities. The overies of one of these specimens contained seventeen eggs, averaging fifty-five hundredths of an inch in length by thirty-five in diameter.

Sceloporus consobrinus B. & G. A Sonoran and Central species, ranging to the north, south and west of Kansas, and doubtless over the western part of the state. Sand-hills, valleys of the Platte (Hayden). Canadian fork (Baird).

Sceloporus undulatus Harl.: Tree Lizard. I have seen a single specimen of this lizard, taken in Rooks county, or vicinity, by Prof. Popenoe. Ft. Riley (Brown).

Crotaphytus collaris Say: Black-shouldered Lizard. Occurs throughout the State. Prof. Popenoe writes: "Rather frequent about Manhattan. Inhabits stone-quarries and rocky hills. Very agile and somewhat difficult to capture. Fights when taken."

Holbrooki maculata Gir.: Cactus Lizard. Neosho river (Brown, Goss) and westward. Prof. Popenoe, who has observed the species in middle and western Kansas, writes that it is found on dry, hot, sandy or stony plains and hillisdes, dodging about clumps of grass or cactus, when pursued, and keeping on the side opposite its pursuer, but never assuming the defensive when caught. He further states that it varies considerably in shade.

ANGUIDÆ.

Opheosaurus ventralis Daud.: "Grass Snake." Well known in many parts of Kansas as the "joint snake." As it is rarely seen except when turned up by the plow, it is nowhere regarded as abundant. Prof. Popenoe writes that he has observed it several times at Topeka, and Prof. Wheeler sends a similar note for Ottawa; Prof. Snow reports it as not uncommon at Lawrence; it is represented in the collection of the Philadelphia Academy, from Republican fork; and I have observed a single specimen in Crawford county. It occurs westward to Bridger's Pass (Hallowell).

TEIDÆ.

Cnemidophorus sexlineatus Linn.: Six-lined Swift. A southern species, extending northward to the Platte (Hayden). One specimen was taken by Dr. Hammond, at Ft. Riley (Hallowell), and seven others, collected by him in "Kansas and Nebraska" (Hallowell), were probably taken near the same point. A specimen taken in or near Rooks county, by Prof. Popenoe, differs somewhat from eastern specimens in having the anterior portions of the body suffused with a blue-green shade, deepest on the sides of the head, and passing insensibly into olive-gray posteriorly. Dr. Coues considers this lizard the most agile of all its tribe, and states that it is emphatically a ground lizard—not a tree or rock species.

SCINCIDÆ.

Eumeces fasciatus Linn.: Blue-tailed Skink. Prof. Popenoe, who has observed this species in Shawnee county, writes that it is common in the woods along Indian creek, preferring damp, shady localities. Taken at Fort Riley by Dr. Hammond (Nolan), and at Lawrence by Prof. Snow.

Eumeces Guttulatus Hallow.: Black Skink. I have received one specimen of this handsome little lizard from Manhattan, through Prof. Popenoe. It is also represented from Kansas in the collection of the Philadelphia Academy (Nolan), and is doubtfully recorded from the upper Arkansas by Baird.

Eumeces obsoletus B. & G. Specimens from Douglas county, where the species seems to be common, exhibit marked variations in color and in the arrangement of the anterior cephalic plates. (See Bulietin 20, U, S. Nat. Mus., p. 39).

Eumeces septentrionalis Bd.: Northern Skink. A single specimen from Neosho Falls is in the National Museum (Brown).

Oligosoma laterale Say.: Ground Lizard. Prof. Popenoe writes that it is not rare at Topeka, occurring with E. fasciatus. A specimen from that locality, for which I am indebted to him, has the scales in twenty-eight rows, There is a specimen from Fort Scott in the National Museum (Brown).

OPHIDIA.

COLUBRIDÆ.

Heterodon simus Linn., var. nasicus B. & G. Fort Riley (Brown), Ft. Hays (Garman), Wallace county (Mozley). A specimen collected by Prof. Popenoe in Phillips county, is in the State House collection. Snakes of this genus are popularly known in Kansas under the name of "blow snakes."

Heterodon simus Linn. Wallace county (Mozley), Ft. Riley (Nolan).

Heterodon platyrhinus Latr., var. atmodes B. & G. Douglas county (Mozley).

Heterodon platyrhinus Latr.: Hog-nose. Three specimens in National Museum from Ft. Riley (Brown), Douglas county (Mozley). A specimen taken by Prof. Popenoe in Rooks county, is in the collection at the State House.

Tropidonotus rhombifer Hallow.: Holbrook's Water Snake. Douglas county (Snow).

Tripodonotus sipedon Linn., var. erythogaster Shaw: Copper-belly. Kansas (Cope).

Tropidonotus sipedon Linn.: Water Snake. Douglas county (Mozley), Ft. Riley (Brown). Fifty miles northwest of Ft. Riley (Nolan). The collection at the State House includes a specimen from Saline county.

Tripodonotus grahamii B. & G.: Graham's Snake. Taken in Douglas county (Snow).

Tropidoclonium lineatum Hallow. This species, first described by Hallowell in 1856, was based on specimen taken in Kansas by Dr. Hammond Two specimens, taken in Douglas county, are in the museum of the State University (Snow); and another, from Neosho Falls, is in the National Museum (Brown).

Storeria dekayi Holbr.: De Kay's Brown Snake. Taken in Douglas county (Snow). One specimen in the National Museum, from Kansas (Brown).

Storeria occipitomaculata Stover: Spot-necked Snake. Taken in Douglas county (Snow). Taken in Kansas by Dr. Hammond (Nolan).

Eutænia sirtalis Linn., var. parietalis Say: Parietal Garter Snake. Taken at Manhattan and at Topeka by Prof. Popenoe. Ft. Riley (Nolan). Douglas county (Snow, Mozley). Prof. Popenoe mentions this as one of the commoner species in his experience, and writes that it takes to the water as readily as tropidonotus.

Eutænia sirtalis Linn., var. ordinoides B. & G. Taken in Kansas by Dr. Hammond (Nolan).

Eutænia sirtalis Linn., var. ordinata Linn.: Grass Snake. Taken in Kansas by Dr. Hammond (Nolan).

Eutænia sirtalis Linn.: Common Garter Snake. One specimen in National Museum from Ft. Riley, and one from Neosho Falls (Brown). Douglas county (Mozley). Prof. Popenoe notes this species as about equally abundant with var. parietalis.

Eutænia sirtalis Linn., var. dorsalis B. & G.: Douglas county (Mozley).

Eutænia vagrans B. & G.: Wandering Garter Snake. Ft. Riley (Nolan). In Cambridge Museum of Comparative Zoölogy, from Kansas (Garman).

Eutænia marciana B. & G.: Marcy's Garter Snake. Ft. Hays (Garman). Douglas county (Mozley).

Eutænia radix B. & G., var. haydeni Kenn.: Hayden's Garter Snake, Wallace county (Snow). Manhattan? (Popenoe).

Eutænia radix Say: Say's Garter Snake. On the authority of Prof. Popenoe, I give this species as common. Specimens are recorded from eastern, middle, and western Kansas.

Eutænia fairieyi B. & G.: Fairie's Ribbon Snake. One specimen in National Museum, from Neosho Falls (Brown).

Eutænia saurita Linn.: Ribbon Snake. Douglas county (Mozley).

Bascaniun constrictor Linn.: Black Snake. Common in Crawford county, and not rare in Shawnee. Ft. Riley (Hallowell).

Bascaniun constrictor Linn., var. flaviventre B. & G.: Blue Racer. Common in Crawford and Shawnee counties. A specimen in the State

House collection, from Clay Center. Prof. Popenoe writes that, next to the Oph. doliatus triangulus, this is the most abundant species.

Pituophis sayi Schleg.: Say's Bull Snake. Ft. Riley (Garman). Douglas county (Mozley). In the State House collection, from Rooks county. Prof. Wheeler, writing from Ottawa, informs me that he has a specimen of this bull snake eight feet in length, and that it occurs there considerably larger.

Pituophis sayi Schleg., var. mexicanus Dum. & Bibr.: Mexican Bull Snake. One specimen in the National Museum, from Ft. Riley (Brown).

Coluber obsoletus Say: Pilot Snake. Ft. Riley (Brown). Douglas county (Mozley, Snow). Ottawa—growing to a length of ninety inches (Wheller).

Coluber obsoletus Say., var. confinis B. & G.: Douglas county (Snow). Ft. Riley (Hallowell).

Coluber vulpinus B. & G.: Fox Snake. Kansas (Cope).

Coluber emoryi B. & G.: Emory's Racer. Ft. Riley (Brown). A Manhattan specimen, loaned me by Prof. Popenoe, has the dorsal scales in twenty-seven rows, and the labials mostly dark-edged, the seventh largest, both above and below. A dark spot enters the orbit on the fourth labial, and extends backward to the sixth. The abdominal blotches show a considerable degree of regularity, being arranged in four rows, one of gray blotches on each side, usually occupying the extremities of alternate scutelæ, and just within each of these another of considerably darker plotches. The inner and outer of these rows, on either side, are strictly complementary, not a single blotch of either lying on the same scutella with one of the row adjacent. On the tail, the blotches of the two outer rows are gradually lost, while those of the two inner approximate, till, on the posterior half, they occupy adjacent scutellæ, and form two nearly continuous black bands.

Cyclophus vernalis DeKay.: Northern Green Snake. An eastern and northern species, occurring westward to Colorado (Coues and Yarrow). Ft. Riley (Nolan). "Neosho" (Brown).

Diadophis punctatus Linn.: Ring-necked Snake. Douglas county (Mozley).

Diadophis punctatus Linn., var. amabilis B. & G..: Central and Eastern regions as far as Ohio (Cope).

Diadophis punctatus Linn., var. docilis B. & G.: Two specimens of punctatus received from Prof. Popenoe, and collected by him at Topeka, represent this sub-species, but with the dorsal scales in seventeen rows.

Diadophis arnyi Kenn. One specimen in the National Museum, from "Hyette, Kan." (Brown).

Ophibolus calligaster Say: Kennicott's Chain Snake. Ft. Riley (Hallowell). Douglas county (Mozley). Neosho Falls (Brown).

Ophibolus getulus Linn., var. sayi Holb.: King Snake. Douglas county (Mozley). Shawnee Mission and Ft. Riley (Brown). A Topeka specimen in the State House collection.

Ophibolus doliatus Linn., var. triangulus Boie.: Milk Snake. Prof. Popenoe writes me that this is the most abundant serpent in the state, and very variable.

Ophibolus doliatus Linn.: Corn Snake. Three Douglas county specimens in the museum of the Kansas State University (Snow). Topeka and

Manhattan (Popenoe). The National Museum and Philadelphia Academy both have specimens from Kansas.

Ophibolus doliatus Linn., var. annulatus Kenn. Kansas (Cope).

Ophibolus doliatus Linn., var. gentilis., B. & G. Wallace county (Mozley). A specimen labeled "Ophibolus Gentilis??" taken by Prof. Popenoe, at Topeka, is in the State House collection.

Ophibolus doliatus Linn., var. coccineus Schleg. Kansas (Cope).

Tantilla nigriceps Kenn. A single specimen in National Museum, from Ft. Riley (Brown).

Carphophiops vermis Kenn.: Worm Snake. Ft. Scott (Brown). Douglas county (Mozley).

CROTALIDÆ.

Ancistrodon contortrix Linn.: Copperhead. Prof. Popenoe writes from Manhattan that the copperhead is neither rare or common at that point. A small specimen which he sends is rather darker than is the rule with eastern specimens. Douglas county (Mozley).

Caudisona tergermina Say: Massasauga. Douglas county (Mozley). Near Ft. Riley (Nolan).

Caudisona Edwardsii B. & G. Topeka, one specimen (Popenoe).

Crotalus confluentus Say: Missouri Rattlesnake. Two Rooks county specimens are in the collection at the State House. Ft. Haye (Garman). Osborne City (Mozley). Ft. Riley (Nolan). Wallace county (Snow).

Crotalus horridus Linn.: Banded Rattlesnake. Douglas county (Snow). One specimen in National Museum (Brown).

ANURA.

RANIDÆ.

Rana catesbiana Shaw: Bull Frog. Prof. Popenoe writes: "Topeka and Manhattan; rather common; inhabits only deeper streams."

Rana halecina Kalm.: Leopard Frog. Of this species Prof. Popenoe writes again: "Abundant found on margins of all water."

HYLIDÆ.

Hyla versicolor LeConte: Northern Tree Frog. In Cambridge Museum of Comparitive Zoölogy, from Kansas (Garman).

Chorophilus triseriatus Wied.: Striped Bush Frog. One of the most abundant batrachians of Kansas. Prof. Popenoe writes: "I have never captured them on trees, but frequently in roadside puddles." Mr. Garman tells me that they often crawl upon bushes two or three feet above the water. They vary greatly both in color and in pattern of their markings. The ovaries of a specimen sent me by Prof. Popenoe contained about four hundred and twenty eggs, and the stomach was distended with a large grub, the head, thorax, and elytra of a species of Aphodius, a small spider and a quantity of apparently silicious matter.

Acris gryllus Le Conte., var. crepitaus Bd.: Cricket Frog. One hundred and fifty miles west of Ft. Riley (Brown). Ft. Riley (Nolan).

ENGYSTOMIDÆ.

Engystoma carolinense Holb. Kansas (Hallow).

BUFONIDÆ.

Bufo lentiginosus Shaw., var. fowlerii Putman: Fowler's Toad. Manhattan and E. (Popenoe).

Bufo lentiginosus Shaw., var. americanus Le Conte: Common Toad. Common at Manhattan and westward (Popenoe). Should be found also eastward.

Bufo lentiginosus Shaw., var. cognatus Say. Two Kansas specimens, one of them from Ft. Riley, are in the National Museum (Brown). A third is in the collection of the Boston Natural History Society (Henshaw).

Bufo lentiginosus Shaw., var. frontosus Cope. Kansas (Brown).

URODELA.

PLETHODONTIDÆ.

Spelerpes ruber Daud.: Salamander. Maine to Nebraska and southward (Jordan).

AMBLYSTOMIDÆ.

Amblystoma microstomum Cope: Small-mouthed Salamander. Kansas (Jordan).

Amblystoma mavortium Bd.: Prairie Salamander. Ft. Riley (Cope). Douglas county (Snow).

Amblystoma tigrinum Green.: Tiger Salamander. Two specimens, received from Manhattan, through Prof. Popenoe, have very short tails—nearly an inch shorter than from snout to behind anus; but as the specimens are small, this shortness may be due to their age. The larger specimen, 5.85 in. in length, has the tail .95 in. shorter than head and body; the smaller, 4.35 in. in length, has it shorter by very nearly the same. The stomach of the larger of these specimens contained two medium-sized grass-hoppers, nearly intact.

Amblystoma punctatum Linn.: Violet Salamander. United States east of the Rocky Mountains (Jordan).

SUPPLEMENTARY LIST.

(Comprising species now known only as extralimital, but more or less likely to be found in Kansas.)

Pseudemys troostii Holbr.: Yellow-bellied Terrapin. Osage river, Missouri (Agass).

Pseudemys concinna Le Conte: Florida Terrapin. Southwestern Missouri (Agass).

Cinosternum pennsylvanicum Bosc.: Mud Tortoise. Austroriparian and eastern region (Cope).

Aromochelys odoratus Latr.: Musk Tortoise. "Have seen specimens from western Missouri." (Agass.).

Maucrochelys lacertina Schweig.: Mississippi Snapper. Florida to Texas, and to Missouri in Mississippi (Cope).

Prynosoma modestum Gir. Albuquerque, N. M., and near Canadian river (Baird).

Eumeces epipleurotus Cope. Ft. Kearney, Neb., and northern boundary of Texas (Cope).

Eumeces leptogammus Bd. Sand-hills, valley of the Platte (Hayden). Central region (Cope).

Eumeces multivirgatus Hallow. Sand-hills, valley of the Platte (Hayden). Central region (Cope).

Eumeces inornatus Bd. Sand-hills, valley of the Platte (Hayden).

Tropidonotus sipedon Linn., var. woodhousei B. & G. Texas to Missouri (Cope).

Eutœnia sirtalis Linn., var. pickeringii B. & G. Pacific region, Minnesota, Texas (Cope).

Cyclophis ætivus Linn.: Southern Green Snake. New Mexico, Texas and western Missouri (Coues & Yarrow). Ft. Smith, Ark., (Baird).

Ophibolus multistratus Kenn. Nebraska (Cope).

Carphophiops amœnus Say.: Ground Snake, western Missouri (Cooper).

Caudisona miliaria Linn.: Ft. Smith, Ark., (Bd).

Crotalus adamanteus Beauv., var. atrox B. & G. Indian Territory and Texas (Cope).

Rana clamatans Merrem.: Green Frog. Ft. Scott, Ark., (Baird).

Spea bombifrons Cope: Central regions (Cope).

Amblytoma obscuram Baird. Iowa (Cope).

Amblystoma opacum Graveuk.: Banded Salamander. An eastern species, westward to Wisconsin and Texas (Cope).

Menopoma allegheniense Harl.: Hellbender. All tributaries of the Mississippi (Cope).

Necturus lateralis Say.: Mud Puppy. Eastern region except New England and eastern Middle States (Cope). Ft. Smith, Ark., (Baird).

BOTANICAL ADDENDA FOR 1879 AND 1880.

Reported by J. H. Carruth.

In my report for 1876 are a few errors which I wish to correct:

Buchnera elongata is not a distinct species, but a synonym of B. Americana.

Physalis viscosa is perennial; and P. pubescens, annual.

Betula lenta should be B. nigra Ait. Red birch.

A Sabbatia between S. gracilis and S. stelaris proves to be S. campestris.

Carex alveoluteus should be C. albolutescens.

In the report for 1877 and 1878 Gonolobus obliquus should be G. lövis or macrophyllus Mx.

In 1879 I tramped three or four months in Miami, Linn, Cherokee, and Labette counties, returning through the second tier. In giving the results of my observations there or elsewhere, I shall refer to the counties. When I do not recollect, I shall put S. E. K. for southeastern Kansas. In reporting plants sent by others I shall give their residences. When I have not seen the plants, I shall give the names of those reporting them.

Mr. J. Henry of Salina and Mr. B. B. Smyth of Great Bend have furnished some plants, and the names of others. I have found some not hitherto reported among plants collected by Prof. Snow in W. Kansas. Mrs. Jewell of Irving has given me a pretty full list of the plants of Marshall county.

Two young men of Miami county, Dr. J. H. Oyster of Paola and Mr. H. Hutchinson of Fontana, are studying thoroughly the botany of that county. Mr. M. H. Panton of Junction City, now of Clay Center, has studied pretty thoroughly the botany of Davis county, and given me the result of his observations.

E. N. Plank, Esq., of Independence, Montgomery Co., has become well acquainted with the plants of that county, and has contributed largely to the present addenda.

Miss E. F. Randolph of Pardee, Atchison county, has given me a few names.

Mrs. Jewell has given considerable time to the Fungi of Kansas, and sent me the names of the genera, so far as known.

In giving names of species not in any books within my reach, and in determining specimens unavoidably imperfect, I have been aided by Mr. E. Hall of Athens, Ills., and by Prof. Alfonso Wood of New York city, whose labors as an explorer and a teacher of botany have just been brought to a close. I feel his departure as a personal loss. I believe Prof. W. was the first to prepare for students a Botany arranged on the Natural System. His synopses of the larger genera gave his work a value beyond any other that I have known.

I have carefully compared the cultivated Jerusalem artichoke, Helianthus tuberosus, with the wild Helianthus doronicoides, and found no difference except that I found the tubers of the latter very small. When I first saw the latter in Kansas, I thought it was the former, and was disappointed in not finding tubers. I have not always found them the past year.

I mark with a (*) plants introduced, and with a cross (†) plants not found east of the Mississippi. I omit the names of the orders.

1149. Anemone Virginiana L. Miami, Linn, Cherokee; Independence, Plank.
1150. A. thalictroides L. (Thalictrum anemoides Mx.) Paola; Ind., Plank.
1151. Ranunculus rhomboideus Goldie. Ind., Plank.
1152. R. pusillus Poir. Labette.
1153. Cocculus Carolinianus DC. Lab., two varities, one larger and earlier. Ind., Plank.

1154. Calycocarpum Lyoni Nutt. Cher.; Ind., Plank.
1155. Berberis, sp. uncertain. Reported to the Horticultural Society as native in Anderson county.
1156. Brasenia peltata Schroeb. Cher.
1157. Nymphea odorata L. Franklin, Linn, Lab.; Pardee, Miss Randolph.
1158. Nasturtium officinale R. Br. Douglas; Junction City, Panton.
1159. Gynandropsis pentaphylla DC. Seen in Atchison by Mrs. Jewell.
1160. Viola rotundifolia Mx. Pardee, Miss Randolph; Ind., Plank.
1161. V. Canadense L. Pardee, Miss R.
1162. V. pedata L. Lab.; Ind., Plank.
1163. V. arvensis DC. Cher., Lab.
1164. † Ionidium lineare Torr. From Irving. Not quite sure.
1165. Lechea major Mx. Cher.
1166. Hypericum sphærocarpon Mx. Miami.
1167. H. sarothra Mx. Lab.; Ind., Plank.
1168. H. Canadense L. Cher.
1169. H. gymanthemum, var. Canadense. Salina, Henry. Same as the preceeding?
1170. H. Drummondii T. & G. Lab.; Ind., Plank.
1171. * Saponaria L. Many places.
1172. Alsine brevifolia Nutt. Cher.
1173. Paronychia dichotoma Nutt. Great Bend, Smyth.
1174. * Portulaca oleracea L. Gardens.
1175. † P. pilosa. Miami; Ind., Plank.
1176. † P. retusa Eng. Ind., Plank.
1177. Talinum teretifolium L. Miami.
1178. † T. calycinum Eng. Sal., Henry. Has 50 or 60 stamens.
1179. † Malvastrum pedatifidum. G. B., Smyth.
1180. Hibiscus Carolinianus Muhl. Lab. Rare.
1181. Linum Virginianum L. Ind., Plank.
1182. * Ailanthus glandulosa Des F. Streets.
1183. Rhus venenata DC. Ind., Plank .
1184. Sapindus marginatus Willd. Soapberry. Sent from Barbour county.
1185. Euonymus Americanus L. Strawberry tree. Ind., Plank.
1186. Polygala polygama Walt. Paola.
1187. P. Seneca L. Seneca snake-root. From Mr. W. A. Burnett, Decatur county.
1188. † Lathyrus ornatus Nutt. J. City.
1189. L. palustris L. Irv., Mrs. J.
1190. † Vicia truncata Nutt. J. City.
1191. Stylosanthes elatior Swartz. Ind., Plank.
1191. " " var. minimus Wood. Leaflets very small.
1192. Desmodium pauciflorum DC. Ind., Plank.
1193. D. Dillenii Darl. Cher.; Irv., Mrs. J.
1194. D. rigidum DC. Irv., Mrs. J.
1195. D. ciliare DC. Cher.
1196. Lespedeza capitata Mx. Typical form, leaves smooth above. Leaves here usually silky both sides. Linn.
1197. L. hirta Ell. Cher.
1198. * Trifolium pratense L. Fields.

1199. * Medicago sativa L. Alfalfa. Streets, Topeka; G. B. Smyth.
1200. Psoralea melilotoides Mx. Lab.
1201. † P. hypogæa Nutt. J. City, Panton.
1202. † P. eglandulosa Ell. S. E. K.
1203. † P. scabra Nutt. J. City.
1204. Astragalus distortus T. & G. Fontana.
1205. † A. goniatus Nutt. S. E. K.
1206. † A microlobus Gr. Sal., Henry.
1207. A. Plattensis Nutt. J. City.
1208. † A. campestris Nutt. From Rice Co., Dr. Oyster.
1209. † A adsurgens Pall. From W. Kansas, Dr. O.
1210. * Robinia hispida. L. Cultivated.
1211. Phaseolus helvolus L. Ind., Plank.
1212. Prunus maritima Wanz. Ind., Plank.
1213. Cratægus punctata Ait. Lab.; Ind., Plank.
1214. C. parvifolia Ait. Lab.
1215. † C. sanguinea Pal. S. E. K.
1216. C. coccinea L. Lab.; J. City, Panton.
1217. Geum strictum Ait. Ind., Plank.
1218. Rubus strigosus Mx. Red raspberry. Seen by Mr. T. Buckman, Topeka; reported also from Greenwood county.
1219. Spirea tomentosa L. Hardhack. Have a specimen. Reported from Wyandotte county.
1220. Rhexia Virginica L. Deergrass. Cher.
1221. † Ammania Nuttallii. Sal., Henry.
1222. Epilobium coloratum Muhl. Irv., Mrs. J.
1223. Œnothera fruticosa L. S. E. K.; Ind., Plank.; Irv., Mrs. J.
1224. Œ. glauca Mx. S. E. K.; Ind., Plank.
1225. † Œ. bicolor Don. Sal., Henry.
1226. Gaura filipes Spach. Ind., Plank.; Irv., Mrs. J.
1227. † G. longifolia. J. City, Panton.
1228. Echinocactus Simpsoni Eng. W. Kansas from Prof. Snow.
1229. Thaspium cordatum Nutt. Leav. Co. from Prof. Snow.
1230. T. barbinode Nutt. Irv., Mrs. J.
1231. Ligusticum actæfolium Mx. Ind., Plank.
1232. Erigenia bulbosa Nutt. Ind., Plank.
1233. † Leptocaulis patens. Sal., Henry.
1234. Cornus florida L. Cher.
1235. C. stolonifera Mx. Lab.
1236. Triosteum angustifolium L. Ind., Plank.
1237. Lonicera flava Sim. Miami; Ind., Plank.
1238. Spermacoce glabra Mx. S. E. K.; Ind., Plank.
1239. Vernonia Nov-Aboracensis Willd. Crawford, Cher., Lab.
1240. V. scaberrima Nutt. Cr., Cher., Lab.
1241. Ageratum conyzoides L. Cher.
1242. Liatris paniculata Willd. One specimen, Topeka.
1243. L. spicata Willy. Linn, Cher.
1244. Eupatorium Mx. Lab.
1245. E. aromaticum L. Ind., Plank.

1246. Conioselinum cœlestinum DC. Ind., Plank.
1247. Aster concolor L. J. City, Panton.
1248. A. squarrosus Walt. S. E. K.
1249. A turbinellus Lind. S. E. K.
1250. A. dumosus L. S. E. K.
1251. A. mutabilis Ait. S. E. K.
1252. A. nemoralis Ait. S. E. K.
1253. Bellis integrifolia Mx. Ind., Plank.
1254. Solidago latifolia L. S. E. K.
1255. S. discoidea Ell. Lab.
1256. S. stricta Ait. S. E. K.
1257. S. serotina Willd. Douglas.
1258. S. rupestris Raf. S. E. K.
1259. † S. angustata T. & G. S. E. K.
1260. S. radula Nutt. Paola.
1261. S. tortifolia Ell. Cher.
1262. † S. incana. J. City, Panton; G. B., Smyth.
1263. † S. scoparia Wood, n. sp. Plant rigidly erect, 2-4ft., scabrous, canescent, branching above into a simple paniculate corymb. Leaves numerous, small, ovatelanceolate, 3-veined, sessile, entire, (lowest not seen,) acute, cauline 1′, those on the simple branches 5″-3″-1″. Heads small, subsessile, crowded in cylindrical terminal spikes. Florets about 8, rays minute, achenia glabrous. Papus of many scabrous white bristles.
1264. †Grindelia robusta? Scales flat; plant tall. Douglas.
1265. Isopappus divaricatus T. & G. From W. Kansas, Prof. Snow.
1266. Polymnia Canadensis L. Miami.
1267. Silphium trifoliatum L. Doug.; J. City, Panton.
1268. Rudbeckia speciosa Wender. Doug.; Cher.
1269. Helianthus giganteus L. S. E. K.
1270. H. microcephalus T. & G. S. E. K.
1271. † H. Nocoletti T. & G. Lab.
1272. † H. Maximiliani Schrad. var. hybrida Wood. Scales shorter than the disk, and little attenuated like those of H. giganteus. Ramial leaves opposite, cauline alternate; all tripli-veined.
1273. † Actinomeris squarrosa Nutt. var exaltata Wood. Stem not winged. S. E. K. A species?
1274. Coreopsis verticillata L. Great Bend, from Dr. Oyster.
1275. C. tripteris L. Cher.; Paola.
1276. C. discoidea T. & G. S. E. K.
1277. † Bidens tenuisecta Gr. J. City.
1278. † Flaveria linearis. Great Bend.
1279. Verbesina Siegesbeckii Mx. Ind., Plank.
1280. † Gaillardia pinnatifidia Torr. Dodge, from Dr. O.
1281. † Artemisia longifolia Nutt. S. E. K.
1282. Antennaria margaritacea Br. Fontana.
1283. Senecio aureus L. var. balsamitæ. S. E. K.
1284. † Tetradymia! Not in Porter & Colter. Lab.
1285. * Cirsium arvense Scop. Canada thistle. Lawrence and Topeka.
1286. † C. ochrocentrum Gr. Sal.

1287. Apogon humilis Ell. Irv.
1288. Lacturca graminifolia Mx.? Leaves 6″ wide, 3′ long. A tooth on one side near the base. Seen repeatedly, S. E. K.
1289. Mulgedium acuminatum DC. Linn, Lab.; Ind., Plank.
1290. M. Floridanum DC. Doug.
1291. M. leucophæum DC. G. B., Smyth.
1292. Sonchus oleraceus L. Doug., Fontana; G. B., Smyth.
1293. Lobelia inflata L. Linn.
1294. Specularia Ludoviciana Torr. Miami.
1295. Vaccineum vacillans Poland. Blueberry. Cher.
1296. Ilex decidua Walt. Lab.
1297. Bumelia lanuginosa Pers. Cher.; Ind., Plank.
1298. Anagallis arvensis L. Miami.
1299. Utricularia gibba L. Cher.
1300. Tecoma radicans Juss. Cher., Lab.; Plank.
1301. * Catalpa bignonioides Walt. Streets.
1302. † Pentstemon Fendleri. G. B.
1303. † P. Brandegei Porter. Lab.
1304. P. digitalis Nutt. Doug.
1305. Gratiola Virginica L. Sal., Henry.
1306. Veronica arvensis L. Lab.
1307. Dasystoma flava Wood. Miami, Lab.
1308. † D. pectinata Torr. From Mr. J. Wilson, Arkansas City.
1309. Gerardia Skinneriana Wood. Cher.
1310. † G. densiflora Boott. J. City, Panton.
1311. Castilleja coccinea Spreng. Cher., Lab.
1312. * Mentha viridis L. Spearmint. Topeka; Ind., Plank.
1313. Salvia azurea Lam. S. E. K.
1314. Scutellaria canescens Nutt. One specimen, Cher.
1315. Heliophytum Indicum D.C. S. E. K.
1316. Lithospermum arvense L. Linn, Cher.
1317. Mertensia Virginica DC. Paola.
1318. Myosotis palustris Rath. Paola.
1319. † Eretrichium Kansense Wood. n. sp. Sent from Oswego to Prof. Wood by W. S. Newlon, M. D. Description not seen.
1320. Hydrophyllum appendiculatum. Mx. Douglas. Reported to Prof. Snow.
1321. Phacelia hirsuta Nutt. Lab.
1322. † Collomia linearis Nutt. Lab.
1323. Gilia coronopifolia Pers. Ind., Plank.
1324. Batatas macrorhiza Wood. Paola. Oyster.
1325. † Evolvulus sericeus Swtz. G. B., Smyth.
1326. † Bonamia Pickeringii, var. with styles and stigmas like an Ipomea. Prof. Wood thought it a n. sp. of Ipomea.
1327. Solanum sisymbrifolium Lam. Neosho Co.
1328. † S. eleagnifolium. Great Bend.
1329. † Physalis heterophylla Nees. S. E. K.
1330. * Datura tatula L. Roadsides. Dr. Gray inclines to call it a species.
1331. † Withania coronopus Torr. From W. Kansas by Prof Snow.
† Sabbatia campestris. (See introduction.)

1332. †Eustoma Russellianum. From W. Kansas by Prof. Snow; Great Bend.
1333. Amsonia salicifolia Ph. Allen.
1334. Asclepias variegata L. Ind., Plank.
1335. A. quadrifolia Ph. Ind., Plank.
1336. Fraxinus pubescenes Walt. Red ash. Lab.
1337. F. platycarpa Mx. Gray ash. Lab.
1338. F. quadrangulata Mx. Blue ash. Lab.
1339. F. sambucifolia Lam. Black ash. Reported to the Horticultural Society from several counties.
1340. Aristolochia tomentosa Sims. Ind., Plank.
1341. † Oxybaphus hirsutus Ph.? W. Kansas, Prof. Snow.
1342. Eriogonum tomentosum Mx. G. B., Smyth.
1343. Rumex hydrolapathus Huds. var. Americanus Gr. S. E. K.
1344. R. salicifolius Huds. Sal., Henry.
1345. R. sanguineus L. Ind., Plank.
1346. R. hastatulus Baldw. (R. Engelmanni Leder.) Doug.
1347. Polygonum sagittatum L. Scratch grass. Cher.
1348. Chenopodium polyspermum L. Linn.
1349. C. urbicum L. Lab.; Ind., Plank.
1350. † Monolepis Nuttalliana. Sal., Henry.
1351. † Atriplex hastata, var. Purshiana. G. B., Smyth.
1352. † A. spicata. G. B., Smyth.
1353. Chenopodina Maritima Moq. G. B., Smyth.
1354. Iresine celosioides L. Cher.; G. B., Smyth.
1355. † Frœlichia gracilis Moq. Cher.; Sal., Henry; G. B., Smyth.
1356. † Euphorbia montana Eng. J. City, Panton.
1357. † E. petaloidea Eng. J. City, Panton.
1358. † E. revoluta Eng. J. City, Panton.
1359. E. Geyeri Eng. Lab.
1360. † Tragia nepetæfolia Muller (stylaris of some). J. City.
1361. Ulmus alata Mx. Cork Elm. Reported from the Saline river by Mr. A. D. Bailey, Wa-Keeney.
1362. Celtis Mississippiensis Bosc. Cher.
1363. C. crassifolia. Var. or species of hackberry. S. E. K.
1364. Boehmeria cylindrica Willd. Cher.; Sal., Henry.
1365. Callitriche heterophylla Ph. Sal., Henry.
1366. Carya tomentosa Nutt. Ind., Plank.
1367. Quercus aquatica Mx. Linn, Lab.
1368. Q. lyrata Walt.? Leaves agree. Miami and south.
Betula nigra Ait. Red Birch. Cher.; Ind., Plank. (See introduction.)
1369. Alnus serrulata Willd. Alder. Reported to the Hort. Soc. from several counties.
1370. Salix discolor Muhl. Cher.
1371. S. angustata Ph. Cher.
1372. S. myricoides Muhl. Doug.
1373. S. lucida Muhl. Doug.
1374. Populus angulata Ait. Shawnee.
1375. * P. dilatata Ait. Lombardy poplar. Streets.
1376. * P. alba L. Silver-leaf poplar. Streets.

1377. Acorus calamus L. Sweet Flag. Cher.; Paola.
1378. Potamogeton diversifolius Bart. Cher.; Paola.
1379. P. lucens L. Irv., Mrs. J.
1380. P. spirillus Tuckm. J. City, Panton.
1381. P. rufescens Schrad. Sal., Henry.
1382. Sagittaria simplex Ph. Ind., Plank.
1383. S. graminea Mx. Sal., Henry.
1384. Smilax hispida Muhl. S. E. K.
1385. S. glauca Walt. S. E. K.
1386. † Erythronium propullanus Gr. J. City, Panton. Buds underground like Podophyllum.
1387. Streptopus amplexifolius DC. Ind., Plank.
1388. Juncus polycephalus Mx. S. E. K.
1389. J. articulatus L. Lab.
1390. J. acuminatus Mx. Lab.; Sal., Henry.
1391. J. Greenii O. & T. Lab.
1392. Commelyna communis L. Lab.
1393. C. erecta L. Miami.
1394. Tradescantia rosea Mx. Ind., Plank.
1395. Cyperus echinatus Ell. Linn.
1396. † C. glomuliferus Schrad. S. E. K.
1397. † C. Carruthii Wood, n. sp. Biennial; culms triquetrous, slender, 6′ high, the leaves longer. Umbel simple, almost capitate. Spikes, 4--6-flowered, 2″--3″ long, terete, very acute. Rachis with short, trigonous, winged joints. Allied to C. Michauxianus Schult. S. E. K.
1398. C. Nuttallii Torr. S. E. K.
1399. † C. strigosus var. capitatus Wood. S. E. K.
1400. Killyngia pumila Mx. J. City, Panton.
1401. Eleocharis quadrangulata R. Br. Lab.
1402. E. acicularis R. Br. Salina.
1403. Fimbristylis argentea Vahl. Cher.
1404. Carex gynandra Sch. Lab.
1405. C. Shortiana Dew. Lab.
1446. C. lupulina Muhl. Lab.
1407. C. Woodii Dew. Lab., Miami.
1408. † C. Buxbaumii Wahl. var. turgida Wood. Perigynium almost as broad as long, finally dark brown; orifice sub-entire.
1409. Leersia lenticularis Mx. J. City, Panton.
1410. †Sporobolus montanus. Sal., Henry.
1411. Alopecurus geniculatus. Sal. Henry. An Alopecurus common in Topeka is only half as tall as A. geniculatus or aristulatus, is glaucous like the latter, and has awns like the former.
1412. Aristida dichotoma Mx. Linn., Cher.
1413. † Muhlenbergia gracilis Gr. Lab.
1414. Paspalum virgatum L. Lab.
1415. P. virgatum var. flexuosum Wood. Stouter. Spikes more and longer Rachis flexuous. A species? C.
1416. Panicum agrostoides Muhl. Cher.
1417. P. xanthophysum Gr. Doug.

1418. P. latifolium L. Lab.
1419. Oplismenus Walteri. (Panicum.) From Mr. J. Wilson, Arkansas City. Also Linn, Cher.
1420. † Setaria perennis. Between S. viridis and S. glauca. Sal., Henry. Perrennial, or biennial from being sown late?
1421. * Pharlaris Canariensis L. Escaped from cultivation.
1422. Bromus unioloides H. B. K. Shawnee.
1423. Tricuspis stricta Wood. A fine grass, described only in the class-Book. Why? Cher.
1424. Bromus ciliatus L. var.? Spikelets only 3--4-flowered. Fontana.
1425. Festuca duriuscula L. Doug.
1426. F. elatior L. Fontana.
1427. †Poa tenuifolia Nutt. Sal., Henry.
1428. Glyceria elongata Trin. Great Bend.
1429. †Elymus sitanion Schult. W. Kansas, Prof. Snow.
1430. Leptochloa filiformis R. & S. Linn.
1431. †Chloris verticillata. Great Bend.
1432. Spartina juncea Willd. Doug.
1433. Andropogon tetrastachys Ell. W. Kansas.
1434. †A. tener. W. Kan.
1435. †Sorghum! Halepense? Panicle white. Cher.
1436. Aspidium acrostichoides Willd. Cher.
1437. Trillium erectum L. Bath flower. Reported from Paola by Prof. Wherrell. Belongs after No. 1385.

Introduced	13
Not east of the Mississippi	71
Number added	389
Whole number	1,437

APPENDIX.

A list of some of the larger Fungi in the Blue River Valley, by Mrs. E. C. Jewell.

In the hope of entering into communication with other students of Fungology, I venture to send a brief preliminary report of such fungi as I have been able to identify positively as growing in Kansas.

My facilities for such work are limited to a good Wetzler microscope, and a volume of Berkeley's Outlines of British Fungology, which gives no description of microscopic species—with such stray helps as magazine articles, encyclopedias, agricultural reports, etc. I have seen only British works —never even a catalogue of American plants. Of course I have recorded much that I cannot report, for I know of no name for most of my finds.

The best naturalists themselves are readjusting their system, since the discovery of the alternate generation of many of the lower orders makes it certain that many plants have had several names apiece allotted to them in the best lists—even Berkeley's. For this reason I report only the larger ones now.

I would most gladly exchange observations and such tentative knowledge as I possess with any other observer in the same field.

LIST.

AGARICINI.

Agaricus, species.....8+
Coprinus, species.....5
Schizophyllum commune.....1

POLYPORI.

Boletus, species.....1
Polyporus, sp.....6+

HYDNEI.

Hydnum, sp.....1

TREMELINI.

Hirneola auricula.....1

CLAVAREI.

Clavaria, sp.....2+

PHALLOIDEI.

Cynophallus, sp.....1

TRICHOGASTERS.

Geaster, sp.....1
Lycoperdon, sp.....5

MYXOGASTERS.

Lycogala, sp.....1

NIDULARIACEI.

Cyathus, sp.....1+

PUCCINÆI.

Puccinia, sp.....1+
Ustilago maydis.....1
Podisoma 1

ELVELLACEI.

Marchella, sp.....1
Peziza, sp.....1

Being 11 orders, 18 genera, and more than 39 species. Of these, only the Puccinia and the Lycogala are minute. I hope to report further hereafter.

TRACES OF THE ABORIGINES IN RILEY COUNTY.

By Prof. G. H. Failyer, State Agricultural College.

Animated by several rich discoveries in our midst, a few of us of the Agricultural College found time, during the closing weeks of last spring term, to make some examination of the burial mounds and pottery fields in the vicinity of Manhattan. This work was partially under the direction of and by a college organization known as The Scientific Club, and to some extent by individual effort—all, however, by members of the club. I therefore come before you more as a representative of these labors collectively, than of my own actual work. I shall simply present some account of the work in

this line without indulging in generalizations; premising that more extended investigations must be made ere we are justified in more than outlining possible hypotheses regarding these ancient inhabitants.

In various portions of Riley county are found abundant evidence of the existence of a people long since departed from their once familiar haunts. These evidences are found in their burial mounds containing implements, utensils and ornaments, and in the sites of their pottery yards and kilns. These shall be described more in detail.

In making some investigations along the track of the tornado of May 30, 1879, which passed near Stockdale, my attention was called to the flint arrowheads and fragments of pottery which from time to time had been picked up in a field just south of and bordering upon the little town of Stockdale. A few specimens were then collected. Nothing further was done with this until our party of eight, accompanied by Gov. Green, who resides near Stockdale, repaired thither on the 22nd day of May, 1880. This field belongs to a Mr. Condray. It covers about forty acres, and has been in cultivation for upwards of twenty years. After each plowing, fragments of pottery with the well-known grass-marks, and variously ornamented, arrowheads, scrapers, etc., have been picked up. When we visited it, there was a growing crop on the field; but, being corn which was yet small, a pretty fair view of the field could be had. Extensive digging, however, was out of the question. At various places over the field were elevations one to two feet in height. These were evidently the sites of furnaces or other structures where their pottery was burned. The height of these elevations had probably been reduced considerably by the plow. Removing the soil one and a half to two feet in depth, limestone plainly showing the action of fire was found. This, seemingly, was used as the floor of their kilns. Pieces of burned clay, not mixed with sand, and fragments of pottery, were especially abundant about these kilns. It must be borne in mind that pottery and flint implements are scattered all over the field. When the removal of the crop will permit, the club intends to complete the work, making surveys, etc. I have here specimens obtained in this field. For comparison with those obtained from burial mounds, I invite careful examination of them. From a burial mound near by, containing fragments of very much decayed bones, were obtained a few small pieces of pottery and a few beads and arrowheads. This mound is on a bluff facing the east. But as this is the general direction of the bluff, it seems no effort was made to secure such position.

Three miles north of Stockdale is another point in which very interesting discoveries were made by Mr. S. C. Mason, a college student. In the center of a large field on the west bank of the Blue river is a slight rise in the surface. But when first occupied it consisted of a square forty feet to the side, and enclosed by a low wall of earth. The mound was opened, and two fire-beds ten feet apart were uncovered at a depth of two feet. These were stone, three feet square, burned quite red, and broken by the heat. All about these fire-beds, and below the depth to which it had been plowed, the soil was mixed with ashes, charcoal, burnt clay, flint chips and fragments of pottery. The charcoal was from three varieties of wood. The diameter of some of the vessels, as determined from the fragments obtained, was nine inches to a foot. This was March 6th, 1880. Two miles from the mouth of Mill creek Mr. Mason found a similar bed, partly washed away by the

stream. An hour's work here yielded pottery, flint implements, charcoal, and a wasp's nest burned black; and Mr. Mason thinks it the oldest mud-dauber's nest on record. The specimens before you are from these places.

On the 29th of May last, we opened some mounds one mile east of Manhattan, and on the opposite bluff of the Kansas river, at a sharp angle in the bluff. One of these contained, in addition to the fragments of bones, a few arrow-heads and beads. The other one gave better returns for the labor. There were burials at two levels. The upper portions of the first skeleton reached were so far decayed that only the teeth and small fragments of the skull could be found. These showed the action of fire. The larger bones of the limbs were in such position from the teeth as to indicate a reclining posture. In the position where we judged the head ought to be, several fragments of pottery were to be found. Put together, they form the portion of a vessel before you. Whether this was a true burial urn, I do not assert; but the intricate ornamental figures upon the urn betoken no ordinary vessel.

About one foot below this skeleton, and two feet west of it, was another. It was better preserved, and many of the bones were taken out; but they were fragile and easily broken. This body had been placed in a sitting posture, facing the east or northeast. No arrow-heads, pottery or beads were found about this skeleton.

For more than a year one of our young men, Mr. W. J. Griffing, has been hunting up these burial mounds and opening them. On last Thanksgiving day he invited me to assist him in the further excavation of a mound about three miles west of Manhattan, on a high point of the bluff between the Kansas river and Wild Cat creek. A rain soon put a stop to our operations. But Mr. Griffing has, at intervals, continued the work, finding many things of interest. At various times these articles have been unearthed at this place. They consist of arrow-heads, rimmers, fleshers, beads of shells and birds' bones, pieces of bone implements, and, perhaps of greater interest, a piece of copper. This appears to have been hammered into shape.

About fifty yards south is a still smaller one. Diligent search has revealed only portions of skeletons. About one dozen of these have been found. Whether this is the site of more recent burials, or whether it is the grave of inferiors, women or slaughtered enemies, I can only conjecture. But, in studying these remains to determine to what manner of people they belonged, we should not lose sight of the seeming relation between these two burials mounds.

On the same bluff, and three-fourths of a mile south, is another mound. In this were found articles similar to those in others, but a very large number of beads of birds' bones. This latter and the following were worked up by Mr. Griffing. On a very prominent point about three miles east of Manhattan, Mr. Griffing opened a mound, securing thirty-four arrow-heads, nearly one hundred and fifty shell beads, and over three hundred bone beads. Here are some of the relics from this mound.

The lamented Prof. Mudge and Dr. Blachly, on Nov. 17th, 1879, opened the mound on the summit of Bluemont. This mound, which was formerly supposed to be natural, is the largest of which I have learned. Numerous specimens were obtained by these gentlemen. These beads and flint implements were found. But to these must be added others.

Mr. Griffing, who has done more work in this line in our vicinity than any other one person, dug over the dirt thrown from the mound, and was rewarded by obtaining spear and arrow-heads, a bone fish-hook, etc.

I have here some arrow and spear-heads that were found scattered over the prairie.

A locality which promises rich returns is the Wild Cat bottom, near the college. An abundance of pottery in small pieces has been found. A few days since, I spent an hour there, finding, at one place in the creek bank, and three feet below the present surface, bits of charcoal and pottery. Sinking a hole eighteen inches each way in an elevation in the bottom, three bits of pottery and several pieces of burned clay were taken out. I am confident pottery was made and burned here. The work at this point shall be followed up at the earliest opportunity.

It is not to be understood that all the small mounds in which portions of skeletons are found have contained implements, tools and ornaments. More than half have yielded only portions of skeletons. The locations of these mounds are similar, so far as I have been able to determine. All are on the highest hills. They are at present from six inches to two feet high, and in rare cases four to six feet; are composed of black earth and stone, with sand at bottom in some cases. The stones are weather-worn, being surface stones. There is always the appearance that the mound is stone-capped; but this has probably resulted from the washing away of the dirt. This has probably reduced the height very much.

Several questions are suggested by these discoveries. Prominently among these are, whether the pottery and the mounds were made by the same people. Are all the mounds the work of the same race; or are some more recent? Are any or all of these remains those of the people known further east as Mound Builders? Work in excavating these mounds should be systematic, having in view the answering of these and other questions, and should not be induced by the curiosity of the relic seeker. As yet we have not sufficient data to answer the questions. But a somewhat careful comparison of the collection placed before you has inclined me to believe that some of the mounds, at least, were made by the people living in the bottoms where pottery is now found abundantly.

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